PLANT AND ENTOMOLOGICAL SCIENCES
II CROP PROTECTION

ANNUAL REPORT OF THE
NATIONAL RESEARCH PROGRAMS
1977

NATIONAL PROGRAM STAFF
SCIENCE AND EDUCATION ADMINISTRATION
U.S. DEPARTMENT OF AGRICULTURE

This publication reports research involving agricultural chemicals. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife--if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

FOREWORD

II Crop Protection

Research under Program Element 677 Crop Production Efficiency Research has been divided into two parts. Part II includes research under 9 Crop Protection National Research Programs (NRP) and Part I deals with research under 15 Crop Production NRP's. Each part also includes 2 Special Research Programs (SRP).

Research included in this section of the report is conducted to improve crop protection technology including biological and chemical methods to control insects, diseases, weeds, nematodes and other pests while at the same time retaining or improving the quality of our environment.

New multidisciplinary concepts for pest management and control include the development and integrated use of conventional pesticides; behavior control chemicals such as pheromones and attractants; genetic techniques, parasites, predators, pathogens and weed-feeding insects; disease and insect resistance in host plants and plant growth chemicals.

The research workers in the Plant and Entomological Sciences publish the results of their investigations in the open literature as quickly as sound scientific judgment warrants. The purpose of this report, however, is to provide for those interested in the results of this work, a brief overview of the scope of the activities and examples of recent findings, some of which still have not been released by publication. No attempt is made at completeness.

This report outlines the research for which the Plant and Entomological Sciences Staff is responsible and provides a brief description of recent accomplishments at the various locations throughout the United States. The report is organized by SEA National Research Programs, each of which describes a separate subject matter area. The SEA National Research Programs are subdivided into Technological Objectives which more specifically describe the objectives of each area of research.

Readers who have comments or inquiries are invited to contact either the National Program Staff or, more appropriately, scientists at the locations where the research is conducted.

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SUMMARY

Plant and entomological sciences research is an integral part of the total research program in the Science and Education Administration. Research is conducted to improve plant productivity through improved varieties of food, feed, fiber, forage, florist and nursery crops, and turf to develop new crop resources and to develop improved crop production practices. Current emphasis is on research to develop new genetic stocks and varieties, increase yields and quality of crops, improve mechanization and crop production practices and to alleviate the effects of adverse environmental conditions through hardier plants. New multidisciplinary concepts for increasing our productive capacity have been initiated. Special emphasis has been placed on improving basic photosynthetic processes in plants, natural nitrogen-fixing processes in soils and plants, better use-efficiency of both renewable and non-renewable energy resources, and control of plant growth and development.

The research is described under nine National Research Programs (NRP) and two Special Research Programs (SRP).

A brief summary of each NRP and SRP is provided in the front of this volume. More detailed reports for each NRP and SRP follow with selected examples of progress and publications.

NRP 20220 Insect Control - Horticultural Crops

The objective of this National Research Program is to provide through research new or improved methods which may be used to reduce the losses to horticultural crops caused by insects and mites. This research is conducted at 18 locations by about 50 SY's and is currently being reported in about 90 scientific publications. Highlights of this current research include: (1) the development of successful IPM programs for pecans, almonds, and potatoes; (2) biological controls for citrus blackfly, cucumber beetles, and pear psylla; (3) improved lures and/or traps for Japanese beetles and tropical fruit flies; (4) improved chemical controls for mushroom flies, greenhouse whiteflies, cabbage caterpillars, and green peach aphid; (5) advancements in control of insects on cabbage and cucumbers using aluminum foil mulch; (6) improved rearing techniques for codling moth; and (7) expansion of the known host range of the insect vector of citrus stubborn disease.

NRP 20230 Cotton and Tobacco Insects

Research is conducted to develop new and improved practices for controlling insects and mites attacking cotton and tobacco. Practices may be used alone or in integrated systems on a farm-by-farm or area-wide basis, but emphasis is placed on integrating of several methods into a total production system since this approach provides the greatest potential for increasing net income. Control technologies being developed include genetical methods, attractants, parasites and predators, microbial agents, insect and plant growth regulators, insecticides, cultural practices, resistant varieties, and insect growth regulators. Research is also conducted on survey methods, loss thresholds, and descriptive and predictive

insect population models to develop a basis for implementing various control technologies and integrating them into production systems.

Cooperative efforts are underway with the Economics, Statistics, and Cooperatives Service to assess the impact of new developments on insecticide use, costs, and net profit. Since losses due to insect damage and direct costs of control have been estimated to be about $800 million annually, application of research results provides considerable potential for reducing real costs and improving environmental quality, thus benefiting both growers and consumers.

NRP 20240 Insect Control--Grains, Forages, Sugar Crops, and Oilseeds

The primary objective is to develop new and improved control methods, tactics, and strategies to reduce insect caused losses of corn, small grains, sorghum, millets, grass and legume forages, sugarbeets, sugarcane, soybeans, peanuts, sunflowers, and other field crops. Research is conducted at 26 locations involving approximately 63 SY's. This research, in cooperation with State and industry scientists, develops control technologies and integrated pest management (IPM) systems to protect more than 300 million acres of field crops and 1 billion acres of grazing land from insect attack. During the past year progress was made in the development of insect resistant crop varieties; biological, chemical, genetic and cultural control; and in the establishment of economic damaged thresholds essential to the development of IPM systems.

NRP 20250 Basic/Non-Commodity Research for Insect Control

On the understanding that the scientific and technological advances in the next 25 years will be critically important for the United States in meeting food, fiber, and public health needs at home and abroad, in-depth fundamental entomological research is now being conducted. This mission-oriented basic research focuses on insect growth, development, and reproduction, insect behavior and ecology, and candidate insecticides and insecticide chemistry, toxicology, and impacts.

Considerable progress has been made in elucidating chitin biosynthesis, its hormonal control and the mode of action of chitin synthesis inhibitors. Immunoelectrophoretic methods have been developed for studying the mating structure of insect populations. Giant strides have been made in advancing the rearing of the gypsy moth and in producing the gypsy moth virus. Analytical techniques were developed to identify submicrogram quantities of sex attractants. The chemical composition of the corn earworm sex attractant was elucidated.

The terpenoid, linalool, imparts resistance in citrus to fruit fly larvae. Linoleic acid is present in sunflower seeds at concentrations which are toxic to the fall armyworm. Work was continued on the construction of a pesticide data base to use computer-assisted techniques for the recognition and design of improved insect control chemicals. Thirty-one candidate insecticides, 13 candidate insect growth regulators, and 6 candidate repellents were received from industrial laboratories for cooperative evaluation research. Pesticide residue extraction and cleanup procedures were automated; and thereby considerable savings in costs of sample analysis

were realized. A formulation of d-phenothrin in Freon 11 and 12 was developed for disinsecting aircraft.

NRP 20260 Biological Agents for Pest Control

Significant progress was made in 1977 in all technological objectives. Biological agents were discovered, evaluated, introduced to the U.S. or released for control of such major pests as Russian thistle, tansy ragwort, rush skeletonweed, alfalfa weevil, alfalfa blotch leafminer, chestnut gall wasp, gypsy moth, southern pine beetle, larch casebearer, velvetbean caterpillar, lygus bugs and grasshoppers. Research advances were made in the increase, conservation and manipulation native parasites and pathogens for control of corn earworm, tobacco budworm and spruce budworm and other major pests. Basic research provided insights on new virus-like pathogens, in vitro methods for production of insect pathogens and techniques for extending the persistence of microbial pesticides in the field. Major advances in taxonomic research supporting biological and other control programs included preparation of host and distribution data for corn earworm parasites, definition of native insects feeding upon the range weed species mesquite and identification aids for fruit flies in support of the APHIS pest exclusion program. Significant accomplishments were made in the use of automated data systems for cataloging large groups of important insects. These will provide large savings in future systematic revisions and facilitate utilization of taxonomic data. Over 53,000 identifications were made for Federal, State and private organizations in support of U.S. and international research, action and regulatory programs.

NRP 20270 Crop Disease Control and Non-Commodity Research on Plant Pathogens and Nematodes

Scientists in this program seek new knowledge concerning biology, morphology, genetics, virulence, and resistance mechanisms of nematodes and causal agents of plant diseases. The program involves basic, fundamental research aimed at reducing the estimated $8 billion losses in agricultural production due to diseases and nematodes. This research is conducted at 21 locations involving approximately 64 scientists. A major portion of the program is located at Beltsville, Maryland, where research in mycology, nematology, virology, and soilborne diseases is emphasized. Other scientists are stationed at strategic locations throughout the country.

Recent significant accomplishments include (1) the discovery of viroids in germplasm collections, (2) the ability to store viruses under ultracold conditions for extended periods of time, (3) discovery of a new beneficial fungus, (4) determination of a new lesion nematode parasite of corn and soybeans, (5) demonstration of weed control using a nematode, (6) cataloging of lawn fungi, (7) use of tissue cultures for studying the nature of disease resistance, and (8) suppression of root-knot nematodes by crop rotation.

NRP 20280 Weed Control Technology for Protecting Crops, Grazing Lands, Aquatic Sites, and Noncropland

Major emphasis is on multidisciplinary research to develop: (a) fundamental knowledge of the biology, ecology, and biochemistry of weeds and weed populations, and principles and mechanisms for their control by biological, chemical, cultural, ecological, mechanical, physical, and integrated systems that are safe and will avoid or minimize hazards to the environment; (b) new and improved weed control technology that will increase efficiency in the production of food, feed, and fiber crops; and (c) methods that will reduce losses in yield and quality, and the cost of control and energy requirements in crops, grazing lands, ornamental plantings, aquatic sites, and noncropland.

The research directly supports farming for food, feed and fiber production; the extension and education programs of the Science and Education Administration (SEA); the provisions of the Federal Noxious Weed Act of 1974 (FNWA), administered by the Animal and Plant Health Inspection Service (APHIS); Federal Seed Act, administered by Agricultural Marketing Service (AMS); and the operational programs of the Soil Conservation Service (SCS), Rural Electrification Administration (REA), Forest Service (FS), Federal Grain Inspection Service (FGIS), and the Agricultural Stabilization and commodity Service (ASCS), U.S. Department of Agriculture. It also aids in meeting the pesticide registration requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and other regulatory or operational programs of the U.S. Environmental Protection Agency (EPA); Tennessee Valley Authority (TVA); Food and Drug Administration (FDA); Drug Enforcement Administration (DEA); Department of Defnese (DOD); and the Bureau of Reclamation, Bureau of Land Management, Bureau of Indian Affairs, Fish and Wildlife Service, and National Park Service of the U.S. Department of the Interior; and other Federal agencies.

This annual report summarizes basic and mission oriented research progress for 1977. More than 60 new chemicals were evaluated for their weed control effectiveness and safety in about 60 crops, aquatic sites, and rangelands. The first plant pathogens in agricultural history have been developed for weed control and are now ready for widescale use in rice, soybeans, and other crops. More than 20 species of insects are being developed for weed control in crops, rangelands, and aquatic sites. Unique herbicide application equipment that applies herbicides to weeds in crops without getting the herbicides on crops was developed. A technique for applying herbicides directly on crop seeds in the row and obtaining excellent weed control without crop injury was discovered in 1976 and was extended and improved in 1977. Outstanding progress was made in developing new weed control technology that will increase the effectiveness and safety of integrated weed management systems. Total progress in 1977 indicates that the 10-year goals established for this national research program are being achieved faster than expected.

NRP 20290 Agricultural Chemicals Technology for Crop Protection and Modification

Major emphasis is on multidisciplinary research to develop a better understanding of: (a) the structure-biological activity relationships of new chemicals in order to enhance the development of improved herbicides, fungicides, nematicides, insecticides, and growth regulators that are compatible with a quality environment, (b) the nature, behavior, and fate of agricultural chemicals in soils that influence their performance and safety to crops, soils, and nontarget organisms in the environment, (c) the mechanisms of entry, movement, activity, selectivity, metabolism, and fate of agricultural chemicals in crops in relation to their effectiveness and safety to subsequent crops and nontarget organisms, (d) the natural bioconstituents and related synthetic compounds that control physiological and biochemical processes for the development of chemicals to modify plant structure and processes, and (e) automated search, storage, and retrieval systems for relating chemical structure and biological effectiveness of agricultural chemicals including their nature, behavior, and fate in all aspects of the environment.

This research directly supports farming for food, feed, and fiber production; the extension and education programs of the Science and Education Administration (SEA); the Federal Noxious Weed Act of 1974 (FNWA); administered by the Animal and Plant Health Inspection Service (APHIS); Federal Seed Act, administered by the Agricultural Marketing Service (AMS); and the operational programs of other agencies of the U.S. Department of Agriculture. It also aids in meeting the pesticide registration requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and other regulatory or operational programs of the U.S. Environmental Protection Agency (EPA); Tennessee Valley Authority (TVA); Food and Drug Administration (FDA); Drug Enforcement Administration (DEA); Department of Defense (DOD); five agencies of the U.S. Department of the Interior; and other Federal agencies.

This annual report summarizes basic and mission oriented research progress for 1977. More than 100 new chemicals were evaluated for their effectiveness and safety as herbicides, insecticides, fungicides, nematicides, and plant growth modifiers. Outstanding progress was made in improving techniques and systems for the discovery and development of new, improved, selective, biodegradable, and safe pesticides and plant growth modifiers. Excellent progress was made in developing controlled release formulations of agricultural chemicals that will increase their effectiveness and safety, reduce the chances for excessive use, and reduce the risks to nontarget organisms and other components in the equipment. Basic research on how herbicides kill plants resulted in the development of new chemicals which reduce high temperature damage to crops and reduce cold hardiness of plants. This discovery will also provide plant breeders with a screening technique that will aid in the development of crops with greater heat or cold hardiness. Total progress in 1977 indicates that the 10-year goals established for this national research program are being achieved on schedule.

NRP 20300 Pest Control Equipment and Methods

Simultaneous efforts are occurring to improve and develop equipment and methods for both chemical and non-chemical methods for controlling important crop pests, and to synthesize this methodology with predictive models of crop development, pest development, and environmental factors to produce feasible pest management systems for use in crop production. Approximately 20 SY's are involved at 13 locations in 11 States.

Substantial progress has been made in the area of chemical control through the improvement of systems for applying pesticides at ultra-low volumes and the development of equipment to apply toxicants directly from the concentrate container on selected targets and with recirculation of the atomized material. Methods are being devised for the application of biological agents and the mechanical distribution of parasite and predator organisms. Pest management techniques are being developed for cotton, corn, and soybeans.

SRP Minor Use Pesticides

Primary emphasis is being placed on the availability of pesticides for minor and special uses by the agricultural community to assure a continuation of crop and livestock production technology for production, storage, distribution, and marketing of food, feed, seed, and fiber. Research is being conducted at 17 locations involving approximately 4 SY's. Research on over 82 food requests in IR-4 and 600 ornamental requests were research projects during 1977 in Federal Research.

SRP Pilot Testing of Alternative Methods for Pest Control

Thirty-three pilot tests are underway involving ecologically selective methods of managing insects, weeds, plant pathogens, and nematodes. The Deputy Director's Pilot Test Fund provides resources to advance certain desirable technologies toward commercial use which otherwise would remain undeveloped. The status of each pilot test is briefly summarized.

National Research Program 20220

INSECT CONTROL - HORTICULTURAL CROPS

This National Research Program is composed of seven subelements which have as their collective objective to provide through research new or improved methods which may be used to reduce the losses to horticultural crops caused by insects and mites. The program subelements are identified as the control of insect pests of citrus, tropical and subtropical fruit, pome fruit, stone and small fruit, tree nuts, vegetables, and shade trees, nursery, ornamental, and other horticultural crops. Providing technology for protecting horticultural crops from insects and mites is an essential component for the production of steady, reliable, and safe supplies of these crops that are reasonable in cost to the consumer, yet profitable to the farmer.

NPS Contact: M. L. Cleveland PACS Contact: M. T. Ouye

Technological Objective 1.

New and improved methods to reduce losses caused by insects and mites to fruits, vegetables, nut trees, and nursery stock.

Research Locations:

3611	Palmer, Alaska
5202	Fresno, California
5210	Riverside, California
7616	Miami, Florida
7606	Orlando, Florida
7706	Byron, Georgia
5221	Hilo, Hawaii
5220	Honolulu, Hawaii
5704	Kimberly, Idaho
3303	Vincennes, Indiana
3302	West Lafayette, Indiana
1313	Orono, Maine
1108	Beltsville, Maryland
3307	Wooster, Ohio
7711	Charleston, South Carolina
7308	Brownwood, Texas
7202	Weslaco, Texas
5805	Yakima, Washington

Selected Examples of Recent Progress:

The number one insect pest of almonds can be controlled - Fresno, CA. An integrated pest management program consisting of orchard sanitation, early and rapid harvest and insecticidal control of the peach twig borer has given economic control of the navel orangeworm. The economic threshold for applying the controls has been determined. All three control methods are necessary components of good orchard management, as the absence of one may destroy much of the benefit from the other two

measures. As much as $350 per acre can be added to growers' profits when this pest management program is utilized.

Virus potentially detrimental to genetic advancement of muskmelon identified - Riverside, CA. Scientists have identified and described the virus as muskmelon necrotic spot virus first described in Japan. This is the first description of this virus in the United States. It is a potential hazard to the melon industry because it is seed borne mechanically and insect transmitted.

Host range of the citrus stubborn disease pathogen greatly expanded - Riverside, CA. Range now includes representatives of 17 plant families, including onion, the first recognized monocotyledenous host, and bing cherry, the first recognized deciduous fruit tree host. In addition, the cruciferous crop plants, cabbage, broccoli, brussels sprout, and radish, were found naturally diseased by the pathogen for the first time.

A synthetic attractant for California red scale males released - Riverside, CA. The synthetic attractant will increase the efficiency of assessing red scale populations in citrus growing areas all over the world and replace the expensive use of virgin females at a fraction of the cost in areas of California and Arizona. The new tool will serve to find, determine extent of, monitor and possibly control red scale populations. Its judicial use will more accurately point out the need or non-need for chemical sprays; consequently, the total number of sprays now used will be reduced.

Fruit fly trapping improved - Miami, FL. McPhail traps were superior to Rebell, Jackson, and stickyboard traps for the Caribbean fruit fly. McPhail traps containing 2 pellets of hydrolyzed torula yeast caught the same number of fruit flies as those containing 6 pellets. However, those with 2 pellets caught significantly fewer trash flies. No differences in fruit fly catch were observed for McPhail traps that had been painted and those that were not painted. McPhail traps baited with hydrolyzed torula yeast caught more fruit flies than those with other types of bait. Modified codling moth traps caught more flies than Jackson traps. Jackson traps painted arc-yellow caught more flies than those painted other colors or not painted.

Citrus blackfly parasites established - Orlando, FL, and Weslaco, TX. Parasites received from the SEA facility, Weslaco, Texas, during 1976 and released in the Ft. Lauderdale, Florida, area were found to be well established and dispersed during 1977. The parasites have now reduced the blackfly population by about 98%. This represents an excellent cooperative effort between USDA research personnel at two locations (Texas and Florida), as well as with personnel of the State and Federal regulatory agencies.

Pecan production increased under integrated pest managment program - Byron, GA. SEA scientists have demonstrated that insect and disease control in a pecan orchard receiving an IPM program was as good or better than an orchard that received a conventional treatment. Cost of production in the IPM orchard was slightly higher than in the conventional orchard but, with higher yields in the IPM orchard, the cost of production was overcome by a 35% raise in net income in the IPM orchard.

A fruit mimic trap performs as well as a trimedlure-baited trap in capturing Mediterranean fruit flies - Honolulu and Hilo, HI. A black wooden sphere (7.5 cm coated with tangle trap adhesive) attracted and caught both sexes of the Mediterranean fruit fly. The addition of trimedlure, male attractant, showed that this fruit model trap was comparable and at times superior in performance to widely used medfly traps. The fruit mimic trap is a new tool useful for trapping females and also for studying their egg-laying behavior in the field.

Extension of the life of lures with the addition of fixatives - Honolulu and Hilo, HI. The addition of Phantolid, a perfume fixative, to trimedlure doubled the duration of effectiveness of this male Mediterranean fruit fly lure in attracting Mediterranean fruit fly populations in the field. This fixative, discovered in the Hawaiian Fruit Flies Laboratory, can reduce the present cost of trimedlure formulations for detection programs by about 40%. Additionally, the traps need be retreated only one-half as often as at present.

Aluminum foil mulch reduced maggot damage to cabbage and increased yield - Beltsville, MD. Placing aluminum foil as a mulch between rows of cabbage reduced the losses of cabbage caused by root-feeding cabbage maggots. In addition, the cabbage yield was substantially higher, averaging about one pound a head more than the cabbage where foil was not used. In a similar test using aluminum foil between cucumber rows, the cucumber yield was double that where no foil was used. Such use of aluminum foil would considerably aid small growers and home gardeners in increasing their yields.

Control of flies in mushroom cropping greatly improved - Beltsville, MD. Presently used methods to control flies in mushroom houses require frequent (as often as four times a day) applications of several types of insecticides. These flies and the diseases associated with them may reduce mushroom production by 50%. The new method developed is applied but once, uses much less insecticide, and results in better fly control.

Greenhouse whitefly controlled by extra low dosages of insecticides - Beltsville, MD. The greenhouse whitefly is the major pest of greenhouse vegetables and ornamentals. Recommended controls require many insecticide applications because several stages of the pest are not affected by available materials. A treatment was developed that controls nearly all stages at dosages as low as 0.02 grams per liter of spray. As a result, better control is achieved using less insecticide, less frequent applications, and the material is much less toxic to man than the commonly used materials.

Improved potato seed production - Orono, ME. Cooperative research of scientists of SEA and the Maine Department of Agriculture has identified a set of cultural practices to aid potato growers in producing virus-free potato seed tubers. Growers should: (a) use the very best seed tubers for planting; (b) if in an area where viruses have been a severe problem, use a tolerant variety of potato; (c) use a systemic insecticide at planting, and convince neighboring growers to do the same; (d) remove obviously diseased plants during the growing season; (e) destroy potato foliage by chopping and herbicide treatment before aphids migrate

into fields late in the season; and (f) use foliar insecticides late in the season if top-killing has not been done early. By following these practices, the researchers have been able to consistently produce potatoes in Central and Northern Aroostook County, Maine, that meet the State of Maine requirements for highest quality grade.

Improved survey lure for Japanese beetles - Wooster, OH. SEA scientists have discovered that when the recently synthesized Japanese beetle female sex pheromone is combined with the survey lure currently used as a standard throughout the country, an attractant for beetles is obtained that is about twice as effective as the older lure. This newer, more powerful attractant puts a significantly improved tool into the hands of State and Federal officials concerned with the rapid detection of new or expanded infestations of this serious plant pest.

Important synthetic pyrethroid controls cabbage caterpillars - Charleston, SC. An experimental pyrethroid insecticide, usually safe to mammals, applied at very low concentrations to field grown cabbage plants, produced 100 marketable heads almost free of damage caused by caterpillar.

Important parasite of Diabrotica larvae found - Charleston, SC. Investigations are underway with the recent discovery of a mermithid parasite which kills root destroying insects. This work could open the way for developing a national biological control program against larvae of the banded cucumber beetle and corn rootworm complex. These root feeding insects cause millions of dollars in losses yearly to such crops as sweetpotato and corn.

Systemic insecticide prevents development of winged spring migrant peach aphid on peach - Yakima, WA. Potato leafroll virus can be reduced by an area-wide control of the winged spring migrant green peach aphid on peach, its principal overwintering host. Spray programs require critical timing during April when the weather is often unsuitable for spraying and trees are in bloom. Systemic treatments January through March do not present a hazard to bees or predators.

Japanese quarantine against imports of fresh deciduous fruits modified to allow importation of U.S.-produced cherries - Yakima, WA. The codling moth does not occur in Japan and thus Japan has a stringent quarantine prohibiting importation of any fresh pome or stone fruits from any country in which the codling moth is present. A fumigation treatment has been developed for control of the codling moth in harvested sweet cherries and, when combined with effective field control measures and inspection during harvest and packing, is also considered effective against the western cherry fruit fly. Based on this research, Japan has modified the quarantine and will allow the importation of U.S.-produced cherries in 1978. This market has an estimated value of $2 million in 1978 alone.

Rearing codling moth under fluctuating temperature improves vigor and competitiveness of moths for the sterile insect technique - Yakima, WA. Male codling moths reared under a simulated day to night temperature fluctuation responded better to the synthetic sex pheromone than did males reared at a nearly constant temperature. Trap catches are an

indicator of field performance in a sterile release program. It costs no more to rear under a fluctuating temperature regime than under constant temperature. This means that rather than expanding facilities to produce more insects, the same or a better effect can be achieved at no increased cost.

Season-long control of the codling moth achieved through mating disruption with the sex pheromone - Yakima, WA. Season-long control of the codling moth was achieved on pears in the Medford, Oregon, area through mating disruption with the sex pheromone. The pheromone was formulated into the Conrel(R) chopped fiber system and applied to the plots by helicopter in late April, May, and July. A level of control equal to that obtained with a standard insecticide spray schedule was achieved. Use of the pheromone as a control for the codling moth shows great potential as it would be nondisruptive to natural biological control of the pear psylla. Chemical control costs have been as high as $250/acre.

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National Research Program 20230

COTTON AND TOBACCO INSECTS

This National Research Program involves research to develop new and improved control practices which may be used alone or in integrated systems on a farm-by-farm or area-wide basis. Control technologies being developed include genetical methods, attractants, parasites and predators, microbial agents, insect and plant growth regulators, insecticides, cultural practices, resistant varieties and insect growth regulators. Research is also conducted on survey methods, loss thresholds, and descriptive and predictive insect population models to develop a basis for implementing various control technologies and integrating them into total crop production systems. Application of research results will result in insect control at reduced real costs and in improved environmental quality, thus benefiting growers and consumers.

NPS Contact: R. L. Ridgway PACS Contact: M. T. Ouye

Technological Objective.

New and improved ecologically acceptable methods to reduce losses caused by insects and mites attacking cotton.

Research Locations:

5510	Phoenix, Arizona
5502	Tucson, Arizona
7413	Baton Rouge, Louisiana
7102	New Orleans, Louisiana
7502	Mississippi State, Mississippi
7402	Stoneville, Mississippi
7802	Raleigh, North Carolina
3090	Fargo, North Dakota
7203	Brownsville, Texas
7302	College Station, Texas
7709	Florence, South Carolina

Selected Examples of Recent Progress:

Radar used to detect insect movement - Phoenix, AZ. A 10 cm meteorological radar detected single tobacco hornworms at a range of 26 kilometers and detected a cluster of 100 tobacco budworm moths at a range of 27 kilometers. Radar promises to be highly useful in studying long-range migration of insects.

Dominant nondiapausing strain of pink bollworms developed - Phoenix, AZ. Reciprocal crosses of nondiapause and diapause susceptible strains were carried out and run through F_1, F_2, and backcross generations in a vigorous diapause inducing environment. The selected nondiapausing trait was dominant to diapause even under these conditions. Analysis indicated polygenic inheritance with only a small number of gene pairs involved.

Respiration critical for artificial rearing of a tachinid parasite of Heliothis spp. - Baton Rouge, LA. Direct contact of the tachinid larvae tracheal system with the atmosphere is essential for tachinid larvae (especially those that develop quickly) to be reared successfully on artificial diets.

Boll weevil behavior regulated by plant maturity - Florence, SC. In a 3-year study, the first occurrence of diapause and peak migration was closely related to plant maturity and occurred 4 weeks after peak squaring when there were less than 6000 squares/ha. These results indicate that the timing of a diapause control program should be initiated in relation to plant maturity rather than on a certain date.

Pink bollworm overwinters in the San Joaquin Valley of California - Phoenix, AZ. The results of field tests in the San Joaquin Valley of California clearly revealed that diapause larvae can and did survive and emerge as adult moths in the area in the spring. These findings demonstrate that established infestations can overwinter and perhaps develop economic infestations in cultivated cotton.

Quality control procedures established for mass-reared boll weevils - Florence, SC, Baton Rouge, LA and Mississippi State, MS. Procedures for measuring bacteria, pheromone production, percent mating, mortality due to stress, and locomotor activity have been established and use as indicators of quality. Weevils from Florence, SC, produced more pheromone, mated more frequently, and survived stress better than those from Mississippi State and nonirradiated weevils were superior to irradiated weevils.

Five million boll weevils were sterilized using fractionated doses of gamma rays administered to pupae - Mississippi State, MS. Fractionated irradiation of pupae appears to provide an adequate method of sterilization. However, rigid control of conditions during holding, transport, and treatment is essential since there is a very small margin for error.

Irridation of aged boll weevil adults and treatment with an insect growth regulator is superior method of sterilization - Baton Rouge, LA and Mississippi State, MS. Treatment of boll weevils with a single dose of gamma irradiation followed by a brief dip in a solution of the insect growth regulator, diflubenzuron, is a quick and reliable method for inducing sexual sterility. The weevils must first be aged for several days in order to reduce undesirable side effects. This can be accomplished by simply leaving the unfed adults in the larval rearing trays for 4 days before treatment. Weevils treated in this manner were evaluated in small field plots in south Louisiana. For a period of one week, these males were at least as competitive as males treated with the recommended procedure that involved 25 irradiation treatments given to pupae over a period of 4 days.

Presence of pathogens in boll weevil reduces tolerance to irradiation - Fargo, ND. Inoculation of boll weevils with Bacillus subtilus or Psuedomonas aeruginosa reduced longevity of irradiated boll weevils by over 50 percent.

Production of hybrid sterile insects (H. virescens x H. subflexa) for use in experiments for control of budworms successful - Stoneville, MS. Facilities have been readied and equipment is on hand for mass rearing adequate numbers of hybrid moths for experimentation on St. Croix; consistent daily production of 50,000 hybrid pupae has been demonstrated.

Heliothis hybrid females are competitive with native budworm females in attracting and mating with native males - Brownsville, TX and Stoneville, MS. However, hybrid males were not competitive with native males in mating with native females, but since the sterile trait is carried by the hybrid females the limited competitiveness of the hybrid male may not significantly reduce the effectiveness of releases.

Heliothis hybrid produces pupae that diapause and survive the winter in the Mississippi Delta - Stoneville, MS. Also, the periods of spring emergence of overwintered H. virescens and Heliothis hybrids were in synchrony.

Components of female boll weevil pheromone isolated - Mississippi State, MS. Two of the male boll weevil pheromone components have now been isolated from the female boll weevil. A third pheromone component, p-caryophyllene, was also isolated from females. All 3 are needed to attract males in the laboratory bioassay, but these 3 do not attract females. In field tests, the hydrocarbon when added to grandlure (the male pheromone) increases the total capture and the percent male capture, particularly in the early season.

High pheromone producing strains of the boll weevil found - Mississippi State, MS. Three selected laboratory strains of weevils produced more pheromone than the standard laboratory strain. Soxhlet extraction of the frass provided a rapid method of analyzing for the pheromone.

Type of food affects boll weevil responsiveness to traps - Florence, SC. The type of adult diet (percent sugar and quality of protein) had a definite effect on the number of boll weevils that respond to grandlure baited traps. Trap efficiency of boll weevil traps changed during the season since as weevils fed more on bolls they became less responsive to traps.

An inexpensive physical barrier dispenser for the boll weevil pheromone, grandlure, replaces the bulky and more expensive dispenser - Raleigh, NC. A commercially available polyester-coated cigarette filter provides a low cost, easy-to-handle dispenser that has release properties similar to the standard glass physical barrier dispenser.

Improved quantitation of efficiency of boll weevil pheromone traps results from cooperative evaluations - Mississippi State, MS, Raleigh, NC and College Station, TX. In one test, efficiencies of Leggett traps in cotton with boll weevil populations with 15 boll weevils per acre was 50 percent for 2 traps per acre, 67 percent for 4 traps per acre, and 61 percent for 8 traps per acre. Similar data collected from several locations are being used to refine a computer model for estimating efficiency and possibly predicting population levels.

Field cage studies indicate that single component of the budworm pheromone, virelure, will disrupt mating - Brownsville, TX. The use of only one of 2 compounds was more effective in disrupting mating than the use of both compounds.

Night vision equipment used to determine pheromone trap efficiency - Phoenix, AZ. Pink bollworms, tobacco budworms, fall armyworms, and bollworms were observed throughout the night using night vision goggles and they were photographed using infrared techniques to study their behavior. The delta trap for pink bollworm was slightly more efficient than the Sharma trap. Trap efficiency studies using virgin female bollworms showed the electric grid trap to be 43 percent efficient as compared to a directional live trap (13 percent), cone trap (01 percent), or pie plate trap (3.5 percent). Similar trap efficiencies were recorded for the fall armyworms.

Over 36,000 isolates of Bacillus spp. were collected from over 300 soil samples in a study of the distribution of Bacillus spp. in agroecosystems - Baton Rouge, LA and New Orleans, LA. Less than 500 of the isolates were tentatively identified as Bacillus thuringiensis. Serological testing will be used for positive identification and for possible identification of new types.

Three isolates of insect viruses from the Philippine Islands effective against Heliothis spp. - Stoneville, MS. Imported insect viruses are being characterized and will be compared with viruses currently being sold commercially in an effort to provide more effective viruses for control of Heliothis spp.

Improved formulations of microbial pesticides - College Station, TX. Protective formulations of the Heliothis nuclear polyhedrosis virus were made by incorporating the pathogen with ultraviolet (UV) light-screening agents in solid microcapsules bound together with a digestible, water-insoluble polymer. Tests demonstrated that encapsulated preparations of virus containing carbon black or titanium dioxide were highly tolerant of solar or artificial UV irradiation; effective biological activity was maintained for periods well in excess of those for commercial formulations. Field tests against Heliothis spp. in cotton demonstrated treatments with encapsulated and commercial formulations of virus provided protection comparable to that of a standard insecticide.

Spray adjuvent increases efficacy of the nuclear polyhedrosis virus from the alfalfa looper - Phoenix, AZ. In experiments on cotton, after 3 days the NPV with adjuvent had 54 percent activity remaining compared to 20 percent activity for the NPV without adjuvent.

Parasitism of Heliothis spp. larvae in early season was high on wild hosts - Stoneville, MS. Microplitis croceipes was the most important parasite of both H. zea and H. virescens. Parasites in order of importance in H. zea were: Microplitis croceipes, Apanteles margineventris and Campoletis sonorensis. In H. virescens, they were: Microplitis croceipes, Apanteles margineventris, Cardiochiles nigriceps, and Campoletis sonorensis.

Plant size, alternate prey, and predator species composition key factors in predator efficiency - College Station, TX. Spatial distribution within limited areas on cotton plants had little influence on consumption of Heliothis eggs by lady beetles, green lacewings, big-eyed bugs, and minute pirate bugs, but total predation was negatively correlated with plant size. In absence of alternate prey, consumption was proportional to egg density; lady beetle larvae were most efficient and adult minute pirate bugs least. When aphids were present, consumption of eggs by all predators except big-eyed bugs was reduced; green lacewing larvae were most affected. The key factor related to total predation seems to be predator species composition.

Hymenopteran predator of the boll weevil discovered - Mississippi State, MS. The wasp, Cerceris compacta Cresson, was observed to be an active predator of the boll weevil near Hammond, Louisiana.

Lygus bugs reduced by naturally occurring parasites - Tucson, AZ and Stoneville, MS. The nymphal parasite, Leiophron uniformis, and the egg parasite, Anaphes ovijentatus, were found in substantial numbers parasitizing Lygus spp. in southern Arizona. Parasitism as high as 46 percent was found in Mississippi. Management of parasites offers potential for controlling lygus bugs on cotton and other crops.

New procedure for mass-releasing the egg parasite, Trichogramma - College Station, TX. New procedures for mass production and aerial distribution of Trichogramma increase the flexibility, accuracy, and ease of preparing these egg parasites for release in the field. Parasitized host eggs are attached with an adhesive to wheat bran flakes; this facilitates the bulk handling of parasites and their distribution with conventional aircraft equipment. In field trials on cotton and soybeans, aerial releases of parasites resulted in 100 percent parasitism of lepidopterous eggs in some plots with an overall average of 83 percent. The technique provides a rapid and more uniform distribution of parasites throughout a target area, thus increasing potential parasite efficiency, especially at low host egg densities.

Phenylacetaldehyde inhibits oviposition of pink bollworm and other insects - Phoenix, AZ. Applications of phenylacetaldehyde at 3-day intervals reduced numbers of pink bollworms and cotton leaf perforators.

The insect growth regulator, diflubenzuron (Dimilin®), continues to show promise for controlling reproduction of boll weevils with minimum impact on natural enemies - Raleigh, NC, Florence, SC, Mississippi State, MS and College Station, TX. Rates of 1 oz. of active ingredient in emulsifiable oils provide adequate suppression; rates of 2 oz. provide more rapid effects, but rates of 0.5 to 0.75 oz. may be adequate under some circumstances.

Candidate insecticides effective against heavy populations of tobacco budworms - Stoneville, MS, Florence, SC and Brownsville, TX. The synthetic pyrethroids, permethrin (Ambush® and Pounce®) and Pydrin® gave outstanding control while organophosphorus compounds sulprofos (Bolstar®) and profenofos (Curacron®) gave better control than most available standard insecticides. Permethrin, Pydrin, and sulprofos gave good control when used in a program, allowing for use under an emergency exemption from registration.

New insecticides show promise for control of fall armyworms and beet armyworms on cotton - Florence, SC. Curacron®, Union Carbide UC-51762, Bolstar® plus azinphosmethyl, and Pydrin® controlled fall armyworms and beet armyworms in small and large plot field tests.

Budworms from cotton in the Imperial Valley are much more resistant to methyl parathion than budworms from cotton in the San Joaquin Valley - Stoneville, MS. Budworms from Mississippi were 9 times more resistant in 1977 than in 1966; Heliothis hybrids (H. virescens males x H. subflexa females) carried the same level of resistance to methyl parathion as the H. virescens parent.

Promising plant growth regulator, Pennwalt TD-1123, absorbed slowly by cotton foliage but rapidly translocated throughout the plant after absorption - College Station, TX. Large concentrations of parent material accumulated in fruit (ca. 200 ppm in mature seeds). After oral administration to white rats, TD-1123 was absorbed from gut rapidly (peak tissue residues at 15 min. pest treatment); most of the dose was excreted unchanged in urine after 24 hours.

Plant growth regulators reduce available favorable oviposition sites and food for pink bollworms and Heliothis spp. results in reduced insect populations - Phoenix, AZ, Brownsville, TX and Florence, SC. Promising chemicals for plant growth termination include chlorfluenol, Pennwalt TD-1123, and Banvel®.

Pee Dee lines of cotton (PD 659 and PD 8619) exhibit significant levels of resistance to Heliothis spp. - Florence, SC. Under a limited insecticide program, Pee Dee lines of cotton produced about 1500 lb. of seed cotton per acre compared to about 500 lb. for a standard commercial variety.

Sources of resistance to Heliothis spp. and lygus bugs in glandless lines of cotton identified - Stoneville, MS. Some 100 strains were evaluated in the greenhouse and/or field. A combination of okra leaf, smooth leaf, and nectariless provided the highest level of resistance to Heliothis spp.

Nectariless cotton resistant to pink bollworm - Phoenix, AZ. Four years' data in Arizona show that cultivars and advanced strains of cotton lacking extrafloral nectaries reduce seed damage from pink bollworm 15 to 52 percent below that in nectaried cultivars, but yielded as much lint as the latter. Nectariless cultivars will probably not eliminate the need for insecticidal control of pink bollworm, but will reduce that need.

Improved sampling method for Heliothis spp. adults increases accuracy of computer prediction of Heliothis spp. populations - College Station, TX, Brownsville, TX and Stoneville, MS. Studies of efficiency of light and pheromone traps, including role of the physiological state of the moths and of the phenology of plants, is providing a basis for improving the Heliothis population model, MOTHZV. This model is currently being used in extension pest management programs to aid producers in decision making.

Probability of damaging numbers of cotton insects occurring, seasonal abundance of natural enemies, and impact of various predator-prey ratios derived from research support to optimum pest management trial in Panola County - Stoneville, MS. Computerized systems for handling and interpreting data collected over a 4-year period beginning in 1977 have been developed that will make possible the quantifying of many of the variables influencing insect population. Some impact on production practices has already occurred as a result of data collected to date. Additional changes in production practices to reduce insect problems can be anticipated.

Plant growth and fruiting model for Deltapine cotton and population model for pink bollworm developed - Phoenix, AZ. The coupling of the plant and insect models makes possible the study of interactions between the plant, insect, weather, and pest management tactics.

Plant growth models and insect models have been coupled for simulating effects of insect control measures on pest and beneficial insects and yields of cotton in North Carolina and Mississippi - Mississippi State, MS, Stoneville, MS and Raleigh, NC. A wide range of environmental factors including soil moisture, solar irradation as well as temperature and rainfall will be collected along with insect populations, plant growth, and yields will be collected over the next 3 years to validate and improve current models.

Integrated pest management system designed for pink bollworm - Phoenix, AZ. The principal suppression components include resistant varieties, chemical termination, and cultural control. Monitoring procedures using improved loss thresholds and pheromone traps are used to aid decision making.

Technological Objective 2.

New and improved methods to reduce losses caused by insects attacking tobacco.

Research Location:

7803 Oxford, North Carolina

Selected Examples of Recent Progress:

Release of a hemipterous predator and naturally occurring parasites highly effective in controlling budworms and hornworms on tobacco - Oxford, NC. Release of predaceous stilt bugs resulted in doubling field populations when compared to nonrelease fields. Important natural parasites were: Compoletis sonorensis, Cardiochiles nigriceps, and Apanteles congregatus.

A new parasitic nematode of a chrysomelid beetle discovered - Oxford, NC. A nematode, Howardula colaspidi, was discovered parasitizing the grape colaspis beetle. Parasitism of beetles ranged from 3 to 24 percent in northeast North Carolina.

Budworm resistance in tobacco apparently due to nonpreference - Oxford, NC. Four times as many eggs were laid on flue-cured tobacco than on the highly resistant budworm resistant line, TI-1112. The nonpreference appears to be associated with the nonglandular trait of the resistant line.

Integrated pest management system for tobacco insects designed - Oxford, NC. Augmentations of natural enemies using the predaceous stilt bug and applications of microbial agents and selective insecticides, are being evaluated, including economic assessments, in cooperation with the Economics, Statistics, and Cooperatives Service and North Carolina State University.

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National Research Program 20240

INSECT CONTROL - GRAINS, FORAGES, SUGAR CROPS, AND OILSEEDS

This National Research Program involves research in developing new and improved control methods, tactics, and strategies to reduce pest insect populations and losses to corn, small grains, sorghum, millets, grass and legume, forages, sugarbeets, sugarcane, soybeans, peanuts, and other field crops.

NPS Contact: Robert D. Jackson PACS Contact: M. T. Ouye

Technological Objective 1.

Reduce losses in field crops by conducting research to develop new and improved control of insects and mites.

Research Locations:

3611	Palmer, Alaska
5502	Tucson, Arizona
7613	Canal Point, Florida
7702	Tifton, Georgia
5704	Kimberly, Idaho
3302	West Lafayette, Indiana
3407	Ankeny, Iowa
3420	Manhattan, Kansas
7410	Crowley, Louisiana
7412	Houma, Louisiana
1108	Beltsville, Maryland
3508	East Lansing, Michigan
7502	Mississippi State, Mississippi
7402	Stoneville, Mississippi
3402	Columbia, Missouri
5708	Bozeman, Montana
3416	Lincoln, Nebraska
3307	Wooster, Ohio
7317	Stillwater, Oklahoma
5809	Corvallis, Oregon
1302	University Park, Pennsylvania
3608	Brookings, South Dakota
7315	Bushland, Texas
5805	Yakima, Washington

Selected Examples of Recent Progress:

Corn:

Yellow-eyed variant of the corn earworm - Tifton, GA. A yellow-eyed variant of the corn earworm was found in a laboratory culture. After 6 generations of mutant X normal type matings, the viability of the yellow-eyed phenotype increased and a pure yellow-eyed colony could be maintained. A

yellow-eyed strain could prove to be a valuable tool as a biological marker for insects used in field studies.

Effects of sex ratios on a lab culture - Tifton, GA. Useful information was gained through studies of the relationship between male/female ratios and mating, oviposition, and egg hatch of the corn earworm. The data indicate that an increase in percentage of males in adult-holding containers increases the rate of egg production, increases mating, decreases female longevity, and has no effect on total egg production.

Effects of temperature on the corn earworm - Tifton, GA. Studies of the effects of small changes in the holding temperature of the corn earworm revealed that a vapor pressure deficit of 8.41 mgHg, 30.0C provided the most rapid development to the adult stage. A development temperature of 27.8°C is optimum for adult oviposition and fertility. This information is valuable in scheduling an insect rearing program to maximize the utilization of time.

Secondary sex pheromone for fall armyworm identified - Tifton, GA. Z-9-tetradecen-1-ol acetate was proven to be a secondary sex pheromone for the fall armyworm. This chemical, added at 2-10% concentrations to Z-9-dodecen-1-ol acetate, is a suitable pheromone mixture for monitoring fall armyworm adult populations in sex pheromone traps.

Improved efficiency of double-cropped corn - Tifton, GA. Use of an insecticide against fall armyworm, *Spodoptera frugiperda*, on critical whorl stage of corn reduced costs while holding yields above 120 bu/acre. Lowered production costs should greatly enhance the acceptance of this dual-cropping concept in south Georgia.

The impact of a resistant corn on corn earworm, *Heliothis zea* (Boddie), production was demonstrated - Tifton, GA. In a 3-year study at Tifton, Georgia, the resistant corn, 'Zapalote Chico #2454', produced less than one-fourth as many corn earworms as did the susceptible 'White Cross Bantam'.

Yellow-corn earworm resistant inbreds are in final stages of evaluation before release - Tifton, GA. Several breeding populations of corn were evaluated for earworm resistance and advanced into the next cycle of selection to increase the level of corn earworm resistance and agronomic characters.

Insecticides metered into irrigation water give effective insect control on corn - Tifton, GA. Results of preliminary trials with metering insecticides in irrigation water indicate that effective insect control on corn can be achieved. This increases the usefulness of irrigation systems, eliminates the need for specialized equipment for insecticide application, and can increase the effectiveness of insecticides by increasing their coverage of the plant.

Insecticide performance depends upon corn genotypes - Ankeny, IA. Field data indicate that the performance of insecticides (foliar or systemic applications) depend, in part, on the variety of corn. Thus, corn varieties, resistant or intermediate in resistance to 1st-generation borers, should not be treated with insecticides. Further, insecticide

recommendations should take into consideration the level of resistance in the hybrids being grown.

Certain isolates of the microbial insecticide, *Bacillus thuringiensis*, more pathogenic to European corn borer larvae than are others - Ankeny, IA. Some 320 isolates of *Bacillus thuringiensis* representing 16 varieties were tested for pathogenicity against the European corn borer. Fourteen isolates representing varieties *galleriae*, *kurstaki*, and *kenyae* had IU ratings greater than the *B. thuringiensis* var. *kurstaki* isolate HD-1. This is an indication that certain isolates of *B. thuringiensis* are more pathogenic to the corn borer, and have the potential of being successful as a commercial microbial insecticide.

Corn genotype resistant to both first- and second-generation European corn borer developed - Ankeny, IA. This new line was developed by crossing B52 (resistant to 2nd-generation borers) with Oh43 (resistant to 1st-generation borers). This is the first inbred line of corn with resistance to both generations of the corn borer. The line will be released for use in corn breeding programs.

Determined number of genes conditioning resistance to second-generation European corn borers - Ankeny, IA. At least 7 genes condition resistance in inbred line B52 to 2nd-generation corn borers. This information will guide plant breeders in developing corn genotypes resistant to corn borers because different breeding techniques must be employed if several genes are involved than if only one gene is involved.

High southwestern corn borer 1st-brood resistance exhibited by several S_5 lines - Mississippi State, MS. Several S_5 lines within the 1st-brood southwestern corn borer development program exhibited resistance ratings better than 1st-brood resistant genotypes that have been released previously. These lines have been selected as candidates for future public releases.

Effect of 1st- and 2nd-brood southwestern corn borer resistance on the insect - Mississippi State, MS. Lower larval survival and slower larval growth and development were observed for those larvae reared on the resistant genotypes than those reared on the susceptible genotypes. This information is essential to understanding the insect-plant interactions that exist when the insect is reared on susceptible and resistant genotypes.

Effect of fall armyworm resistant genotypes on the fall armyworm - Mississippi State, MS. Data on the number of fall armyworm egg masses oviposited under field conditions on susceptible and resistant corn populations indicated that the susceptible corn was preferred over the resistant corn for egg laying. Also, in greenhouse studies the fall armyworm larvae reared on the resistant corn population were much smaller than those reared on the susceptible corn population. These data suggest that non-preference for egg laying and larval antibiosis are the mechanisms involved in the resistance.

Systemic insecticides control southwestern corn borer - Columbia, MO. Applications of 3.37 and 4.49 kg/ha of carbofuran at planting time were effective for controlling southwestern corn borer for 51 days. Correlations of leaf-feeding damage to average number of insects per plant and to the average total length of tunnels per plant were 0.89 and 0.86, respectively.

Serious virus problem in sweet corn detected - Wooster OH. The high incidence of MDM detected in late-planted sweet corn in northern Ohio coupled with the absence of MDM and MCD resistance in all of the tested commercial and experimental hybrids, dictates the need for a vigorous program for detection of and breeding for MDM and MCD resistance in sweet corn. As an interim solution for areas of high disease incidence, tolerant commercial and experimental hybrids were identified that, when planted, will permit the production of marketable ears from about half of the infected plants.

Effect of winter soil temperatures on western corn rootworm eggs - Brookings, SD. Four years of soil temperature data associated with western corn rootworm eggs, *Diabrotica virgifera*, show that temperatures were low enough over a sufficient time span during two of the four winters to account for the near absence of the western corn rootworm during the summer of 1977 and the prediction that the few surviving that year will again suffer heavy mortality during the winter of 1977-78 where there were not large accumulations of snow. During 1976-77 there were four weeks when the mean soil temperature was between -12°C and -7.5°C at the 0-3" soil depth and four weeks at the 3-6" depth. During 1977-78 both depths were in this temperature range for five weeks.

Reproductive isolation between the northern and western corn rootworms - Brookings, SD. Pre- and post-mating reproductive isolation mechanisms operate between northern and western corn rootworms. Hatchability of hybrids is very low (about 3%) compared with 50-70 percent hatchability for the controls. The data do not support previously published speculations that the two species interbreed in nature. In the past, entomologists have studied and made control recommendations for the two species as if they were one. These results focus attention on the behavioral differences between the species and, therefore, represent a crucial advance in our understanding of the rootworms which leads to refinements in experimental design and approaches to rootworm control.

Small Grains and Rice:

First cereal leaf beetle resistant wheat variety released to wheat growers - West Lafayette, IN. 'Downy', a soft red winter wheat cultivar, was released to wheat growers in Indiana during 1977. This cultivar was developed by SEA, USDA, in cooperation with Purdue University Agricultural Experiment Station. This cultivar possesses the H_5 gene for resistance to Hessian fly and has resistance to leaf rust. This cultivar is expected to reduce cereal leaf beetle populations to low densities in areas where it is grown, thereby reducing losses both in wheat and oats.

Certified wheat surveyed for Hessian fly infestations - West Lafayette, IN. Certified wheat samples collected from 301 fields in Illinois, 285 in Indiana, 338 in Michigan, and 398 in Ohio showed the average percent infestation to be less than 2%. More than 80% of the 1,322 fields sampled in the 4 States were varieties resistant to Hessian fly. This is a continuing program to monitor wheat fields in the Midwest.

Hessian fly resistant varieties do not suffer yield loss when infested with Hessian fly - West Lafayette, IN. Previous research has shown reductions in wheat yields to vary with the percent of stems infested, and number of larvae per culm. Infestations above 20% are reported to reduce yield losses at least 1 bushel per acre. Wheats having the H_3 and H_5 genes for resistance to Hessian fly were evaluated for losses due to infestation of biotype B. The variety Arthur (H_3) that is susceptible to biotype B sustained losses of 20% when compared with the non-infested control. However, resistant Arthur-71 (H_5) sustained no measurable loss when compared with its non-infested control.

Combined resistance to Hessian fly and greenbug located - Manhattan, KS. Populations of plants involving crosses of 'Amigo' (greenbug resistant) and 'Larned' (Hessian fly resistant) varieties were evaluated for combined resistance to greenbug and Hessian fly. Plants resistant to both insects were selected for further development.

Source of resistance identified from new wheat introductions - Manhattan, KS. Of 900 lines of foreign wheat introductions, only 2 heterozygous resistant lines and 1 homozygous resistant line (C.I. 350144) have been identified. Also, 32 triticales and 46 triticale revertant wheat types from the SEA wheat research at Lincoln, Nebraska, were evaluated for Hessian fly resistance. Of the triticales, 5 lines reacted homozygous resistant, and 11 lines were segregating for resistance. Four revertant types were homozygous for resistance and 4 were segregating.

Chemical controls for rice water weevil identified - Crowley, LA. Synthetic pyrethroids used as seed treatments at 8, 16, and 24 g AI/cwt controlled rice water weevil larvae in preliminary trials with no indication of phytotoxicity to seedlings. Counter 15 G at 1.0 lb AI/A controlled rice water weevil larvae. And a combination treatment of Bux 10 at 1 lb AI/A plus 500 lbs/A 16-6-6 fertilizer gave excellent rice water weevil control and increased grain yields 468 lbs/A.

Tolerance to rice water weevil located - Crowley, LA. Five thousand eight hundred and eighty-four individual F_4 plants representing 300 families from a P.I. 162162 x Nato cross were evaluated for rice water weevil tolerance. About 11% of these displayed a high degree of root regeneration. Seed were collected from 40 families for F_5 determinations. Based upon root regrowth ratings high levels of tolerance were identified.

Unique greenbug resistant wheat germplasm released - Stillwater, OK. The joint release by SEA and the Oklahoma Agricultural Experiment Stations of 'Amigo' germplasm was the result of 13 years of research by a SEA geneticist and SEA entomologists. Amigo was developed by using X-ray on a resistant rye x wheat cross in order to eliminate rye characteristics other than the resistance. Seeds have been distributed widely to breeders in the U.S., as well as some in Europe, Central and South America, Asia,

Africa, and Australia. Amigo is the only known source of effective resistance in wheat to the greenbug, a pest that annually costs growers $40 million or more. Also, the research is the only known successful case of translocating insect resistance from an alien plant genus to a cultivated plant.

Sorghum and Millet:

Multiple pest resistance in sorghum breeding populations developed - Tifton, GA. Initial crosses, backcrosses, and the development of F_2 material were made from several midge-resistant sources and midge-greenbug-resistant sorghum. This is the first time that the highly midge-resistant PI383856 germplasm has been utilized along with the new Texas greenbug-resistant germplasm. Research is continuing to develop agronomically acceptable germplasm resistant to both pests.

Grasses and Legumes:

New insect resistant alfalfa cultivar released - Tucson, AZ. A new alfalfa cultivar (CUF-101) with resistance to the blue alfalfa aphid, pea aphid, and spotted alfalfa aphid, has been released for commercial production. The cultivar is the first one developed for resistance to the blue alfalfa aphid and the first one with resistance to three important aphid species that attack alfalfas in Western United States.

Monograph on leafhoppers published - Tucson, AZ. A taxonomic revision of the Tribe Thagriini of the leafhopper subfamily Coelidiinae was published, bringing together a complete treatise of 2 genera and 139 species. One genus and 103 species are new to science, 31 species were generically reassigned, and 14 species already previously described were synonomized.

Twenty-two cultivars of Kentucky bluegrass were evaluated for tolerance to feeding by adult chinch bugs in laboratory tests - Beltsville, MD. There were significant differences in regrowth, yield, percent dry matter and plant survival among cultivars when they were exposed to chinch bug feeding for 2 weeks. Plants were grown in 5-inch greenhouse pots and tested when 1 month old. Insects were confined on the plants within a plastic tubular cage which was divided so that half of the plants in a pot were infested and half uninfested. This method appears promising as a procedure for evaluating the ability of grass cultivars to withstand chinch bug feeding, selecting tolerant plants for breeding purposes, and measuring the impact of chinch bug feeding on plant development.

Methods for rearing and storing the hairy chinch bug were improved and used to maintain populations in the laboratory for winter testing programs - Beltville, MD. Approximately 15,000 adults were collected from the field in October 1977 and successfully stored for 4-5 months at 60° F in cardboard cartons. Large numbers of eggs were collected from these adults to serve as a source of nymphs for laboratory tests and increase chinch bug colonies. This development will allow large numbers of chinch bugs for plant resistance studies to be reared.

Ozone injury had little or no effect on alfalfa resistance to pea aphids - Beltsville, MD. Ozone-treated plants of 5 strains of alfalfa were compared with untreated plants for resistance to the pea aphid by caging 4 adult females on each plant for 7 days and then recording adult survival, living nymphs, and dead nymphs. Higher levels of ozone resistance were confirmed in alfalfa entries that had previous cycles of selection in the greenhouse for air pollutant resistance. The variety 'Team' and the experimental population MSA-CW3AN3, 2 of the 3 entries with higher levels of ozone resistance, also displayed higher levels of pea aphid resistance. This study is one of the first attempts to show the effect of an air pollutant on plant resistance to an insect pest.

A protozoan proved to be effective biological control agent - Bozeman, MT. A 3-year study of a 46,000-acre experiment on use of the protozoan, *Nosema locustae*, for control of grasshoppers was completed in September of 1977. This biological control agent was applied in July of 1975 and produced an average of 75% infection of treated grasshoppers. The pathogen slowly killed some grasshoppers and weakened others in 1975, survived the winter, and contributed to reduced infestations in 1976. No direct effects on grasshopper parasites and predators or other non-target organisms were detected. The pathogen, therefore, is potentially useful for grasshopper management.

Biological control agent of thistle weeds distributed - Bozeman, MT. USDA-SEA scientists conducted a workshop that instructed individuals from 6 Western States about collection and handling of *Rhinocyllus conicus*, an introduced weevil that feeds on thistle seed. About 90,000 weevils were then collected in Montana's Gallatin Valley for release elsewhere. The weevils were progeny of small releases that were begun in 1969. The weevil's primary host, musk thistle, is unpalatable to livestock and, in the absence of the weevil, is an aggressive invader of range and pasture. However, the weevil has given up to 95% control of the thistle. Control with herbicides has typically required at least 2 treatments reported to cost about $4.50 each per acre, which is prohibitive in many cases.

Combination treatment of pathogen and insecticide proven effective for grasshopper control - Bozeman, MT. It has been demonstrated that malathion, an organophosphorous insecticide, is compatible with *Nosema locustae*, a protozoan pathogen of grasshoppers. When mixtures of low rates of the 2 control agents were applied on wheat bran bait to rangeland, the insecticide killed about 50% of a grasshopper infestation within 24 hours and the pathogen infected about 30% of the survivors after 4 weeks. Use of the bait formulation tended to assure that treatments were selective for grasshoppers only and permitted use of only about 2% as much insecticide as is normally needed for full control. An integrated pest management program will be developed which will involve the blending of chemical, pathogen, and selective bait to provide relief from heavy, damaging infestations, and also provide long-lasting control through the introduction of the biological control agent.

New insect resistant alfalfa variety released - Lincoln, NE. This pea aphid and spotted alfalfa aphid resistant variety, 'Baker', was released jointly by the USDA and the Nebraska Agricultural Experiment Station. It is also highly resistant to bacterial wilt and has moderate resistance to downy mildew and potato leafhopper yellowing, and low resistance to

anthracnose. Baker is a winter hardy variety adapted to the north central part of the United States. Certified seed of Baker will be available to growers for spring planting in 1978.

Sex pheromone of a webworm identified - Corvallis, OR. The sex pheromone of the cranberry girdler, a serious webworm pest of grass seed fields, was isolated and identified as Cis-11-hexadecenal. The pheromone will be used to detect infestations before larvae can damage the stand of grass. Once infestations are identified, insecticides can be used on the moths before they lay eggs. This insect is a serious pest of cranberries and the sex pheromone may also be used in the pest management program in cranberry bogs.

Economic loss caused by the alfalfa blotch leafminer determined - University Park, PA. One mine per leaflet reduced crude protein, in vitro dry matter disappearance (IVDMD), and dry weight of leaflets. Most important was the loss in crude protein. One mine/leaflet causes a reduction of 8.86% in crude protein. An overall loss of 2% protein occurs whenever 22% of the leaflets have one mine per leaf. Replacement of a loss of 2% protein with soybean meal would cost approximately $13/acre. Insect control to prevent the protein loss caused by the leafminer would cost approximately $13/acre ($7 for insecticide, $6 for application). Consequently, 2% loss of protein is the break-even point. Losses above this level become economically important. At the above prices, the economic injury level for the alfalfa blotch leafminer, therefore, is approximately 22% of the alfalfa leaflets with at least one blotch mined.

Sugarbeets:

Insecticides applied at planting time give effective control of sugarbeet insects - Kimberly, ID. One unregistered insecticide, Lorsban, applied at planting time was effective in control of the sugarbeet root maggot. Temik applied at planting was effective in control of the sugarbeet root maggot, the sugarbeet leaf miner, and in suppression of curly top, a virus disease transmitted by the beet leafhopper.

Lygus damage to sugarbeet seedlings determined - Yakima, WA. Although many sugarbeet growers on the Northwest apply insecticides to kill *Lygus*, little information was available on the degree and type of damage caused by *Lygus*. Research showed that in a 24-hour period lygus bugs (*Lygus* spp.) caged 1/plant can kill 72% and injure 18% of the sugarbeet plants in the cotyledon stage and can kill 17% and injure 66% of plants in the 2-leaf stage. No seedling plants in the 4-leaf stage were killed and injury was minimal. Thus, control measures against *Lygus* should be initiated when the beets are in the cotyledon and 2-leaf stages. It is estimated that 1 *Lygus* adult can kill an average 0.85 seedling plants/day. This information will be used to develop a pest management system based upon economic population levels.

Sugarcane:

Control procedures for white grubs developed - Canal Point, FL. Ethoprop (Mocap) at 6.7 kg/ha and combined with a surfactant at 2.5 L/ha gave 82% control of *Bothynus subtropicus* larvae. As the insecticide is nonpersistent timing of application and placement of the insecticide is critical.

Continued research is needed to determine application procedures and to develop specialized application equipment.

Life history of major white grub of sugarcane in Florida determined - Canal Point, FL. When the white grub, *Bothynus subtropicus*, was found to be a serious pest of sugarcane, no information was available on the biology of the insect. Research has now shown the insect to be of one generation per year with the primary adult emergency flights from the first of June through the first week of July. Females oviposited in the soil and hatch occurs usually within 2-4 weeks. This information is necessary to develop effective pest management methods.

Release of two sugarcane varieties resistant to the sugarcane borer proposed - Houma, LA. Two sugarcane varieties, CP 70-321 and CP 70-330, shown to be superior in resistance to the sugarcane borer to 6 of the 7 commercial varieties now in use. These varieties are being considered for release to farmers in 1978.

Host finding behavior by the parasite of the sugarcane borer ellucidated - Stoneville, MS. The tachinid, *Lixophaga diatraeae*, is attracted to sugarcane plants infested with sugarcane borer larvae by a volatile substance emitted by the host. The attracted fly crawls rapidly over the plant and contact of fresh host frass by the fly's front tarsi (feet) stimulates the fly to deposit a parasitic maggot (larva) which seeks out the host and parasitizes it. Complete isolation and identification of these substances will enhance our ability to mass produce and manage parasite populations. The above is new knowledge for tachinids in general and specifically for *L. diatraeae*.

Soybeans and Peanuts:

Plant nutrient elements sprayed on peanut foliage affect the biology of the fall armyworm - Tifton, GA. Plant nutrient elements sprayed on peanut foliage altered the feeding preferences of the fall armyworm and produced adverse effects on its biology. Such effects could greatly affect insect population dynamics and control of insects associated with peanuts.

Systemic insecticidal control of the Mexican bean beetle - Beltsville, MD. Carbofuran and aldicarb (systemic insecticides) applied at planting time gave control of feeding damage equal to that of carbaryl sprayed every 2 weeks throughout the growing season.

Progress continues in development of Mexican bean beetle resistant varieties - Beltsville, MD. Over 140 F_7 soybean lines involving crosses with resistant plant introductions 229358 and 171451 were identified as highly resistant to the Mexican bean beetle in field studies. Many of these lines are also resistant to feeding by the Japanese beetle. Laboratory studies failed to identify sources of resistance other than PI 229358 and PI 171451.

Large-scale rearing program for *Heliothis* spp. developed - Stoneville, MS. A large-scale program for rearing backcross (BC) progeny (Fn ♀ x *Heliothis virescens* ♂) has been developed. Facilities include areas for housing 2 brood colonies (BC and *H. virescens*) and an area for mass production. Up to 55,000 pupae have been produced daily, but capability for consistently

producing 100,000 per day is not expected until 1979. This greatly enhances the probability of successfully testing the feasibility of using the BC for controlling *H. virescens* on St. Croix.

Sunflowers:

Native species of sunflowers collected for evaluation for disease and insect resistance - Bushland, TX. Forty-seven of the 50 native species of *Helianthus* were collected to provide a germplasm bank for sunflower improvement and for disease and insect resistance. As several of the species are on the verge of extinction the preservation of this germplasm is very important.

Resistance to insects found in wild sunflower species - Bushland, TX. Resistance to an aphid, *Masonaphis masoni*, was found in *Helianthus ciliaris*, *H. grosseserratus*, *H. maximiliani*, *H. salicifolius*, *H. mollis*, *H.* x *laetiflorus*, and *H. tuberosus*; also, germplasm resistance to damage by the carrot beetle, *Bothynus gibbosus*, was identified.

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GERMPLASM AND VARIETY RELEASES

A new alfalfa variety - Tucson, AZ. CUF-101, a new alfalfa variety with multiple aphid resistance was developed and released jointly by SEA and the California Agricultural Experiment Station. This variety is the first one developed for combined resistance to the blue alfalfa aphid, spotted alfalfa aphid, and pea aphid.

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National Research Program 20250

BASIC/NON-COMMODITY RESEARCH FOR INSECT CONTROL

This National Research Program includes basic research on entomological problems regardless of the affected commodity or U.S. Department of Agriculture Mission. Chemists, physiologists, ecologists, and behaviorists work together in teams to provide the indepth fundamental knowledge needed in applied research programs in insect management.

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Technological Objective 1.

Develop new and improved principles and practices of arthropod control based on the selective disruption of their growth, development, and reproduction.

Research Locations:

7602 Gainesville, Florida
1110 Beltsville, Maryland
3602 Fargo, North Dakota

Selected Examples of Recent Progress:

Stable fly and facefly strongly attracted to surfaces which reflect in the 330-390 nm region - Insect Attractants, Behavior, and Basic Biological Research Laboratory, Gainesville, FL. Spectral reflectance of clear, white, green, and used clear Alsynite fiberglass panels used to attract stable and face flies and panels coated with HM-35 (DayGlo) crystals indicated that the increased reflection of wavelengths in the 330-390 nm region is associated with increased catch of stable flies on traps reflecting these wavelengths. UV brighteners (HM-35) appear promising as inexpensive and disposable materials for coating weatherproof paper in combination with certain fast acting permethrins for control of the stable fly and facefly.

Two parasites strongly suppress fall and beet armyworms - Insect Attractants, Behavior, and Basic Biological Research Laboratory, Gainesville, FL. Apanetles marginiventris and Chelonus texanus were determined to be the principal parasites attacking the fall and beet armyworms. A. marginiventris is the primary mortality agent of fall and beet armyworms in the early portion of the corn growing season, destroying up to 62 percent of young armyworm larvae. C. texanus appears to be more active later in the corn growing season. Preliminary larval collections indicate that this parasite can destroy up to 83 percent of the fall armyworm larvae in Bermudagrass.

Stereospecific synthesis developed for Japanese beetle pheromone - Insect Attractants, Behavior, and Basic Biological Research Laboratory, Gainesville, FL. A stereospecific synthesis for the Japanese beetle pheromone has been developed, thoroughly tested, and made available to several companies that were asked to bid on a commercial preparation of 100-500 g.

Additionally, a small amount of this pheromone, produced by this synthesis in this laboratory is available for 1978 field tests. A new method for the synthesis of homopropargylic alcohols has been developed. We anticipated that this will provide a new synthetic route to E,Z-3,13-octadecadien-1-ol acetate, the lesser peachtree borer pheromone, that avoids impurities that interfere with the activity of this pheromone.

Identification of white peach scale pheromone is eminent - Insect Attractants, Behavior, and Basic Biological Research Laboratory, Gainesville, FL. About 5 µg of pure pheromone was obtained by GC and LC fractionation of the airborne volatiles from female scale collected on Porapak. IR, NMR, and mass spectra were obtained on this pheromone and the structure was further probed by micro-ozonolysis. Synthesis of a tentatively assigned structure is proceeding.

Analytical techniques developed to identify microgram and submicrogram quantities of pheromones - Insect Attractants, Behavior, and Basic Biological Research Laboratory, Gainesville, FL. High resolution glass capillary columns with over 3,000 theoretical plates per meter have been prepared with OV-101, Carbowax 20M, and SP2340 stationary phases and used to resolve several pheromones, analogs, and isomers. The SP2340 columns separate all 4 isomers of 3,13-octadecadien-1-ol acetate. Infrared spectra in which the trans olefinic band at 970 cm^{-1} is clearly distinguishable have been obtained on 100 ng samples deposited on KBr discs with the FT-infrared interferometer. Proton magnetic resonance spectra have been obtained on 500 ng samples in glass capillary tubes collected directly from the gas chromatograph.

Mechanism of resistance of citrus to tropical fruit flies caused by terpenoids such as Linalool - Insect Attractants, Behavior, and Basic Biological Research Laboratory, Gainesville, FL. Tests of effects of host plant terpenes and chemical analogs showed that several compounds present in citrus peel oils are toxic to Caribbean fruit fly eggs and larvae. Of these, the oxygenated compounds are most toxic. Structure-activity tests using synthetic analogs have been initiated with the intent of discovering agents of potential utility for commodity treatments. Tests are being performed to relate observed differences in the resistance of oranges and grapefruit to attack by the Caribbean fruit fly to the composition and amounts of their respective peel oils. Studies are also being conducted to define the basis for the observed decline in resistance of senescent fruit.

Simple eye examination detects inadequate screwworm flies - Insect Attractants, Behavior, and Basic Biological Research Laboratory, Gainesville, FL. The competence of factory-reared sterile flies to function effectively in the field can be affected by many factors, such as genetic make-up, diet, heat, crowding, etc. A simple electronic test was developed that can immediately detect physiological changes that result in poor performance. This procedure is now routinely used in screwworm fly factories to monitor fly quality.

Time-lapse cinematographyreveals visible morphological events in the life cycle of tobacco hornworm - Metabolism and Radiation Research Laboratory, Fargo, ND. Time-lapse cinematography studies were used to detail the behavioral activity and surface morphological changes during the life cycle of tobacco hornworm. Numerous new observations were made of phenomena that appear to be endocrine mediated. Such observations include body wetting, wandering, and burrowing activities in 5th-instar larvae. All activities such as hatch, feeding, molt sleep, molt, and pupationwere timed on diapause and nondiapause insects.

The phenomenon of body wetting (previously termed "body biting") in which 5th-instar larvae stop feeding and begin an activity that results in coating the body with an oral secretion was observed in all larvae examined. Body wetting is the only activity that was phased with the time of day, and it occurred most frequently between 8 and 10 p.m. The activity was seen in late 5th instar larvae on the 19th day after oviposition date of the eggs and lasted 3.90 ± 0.94 hr (n = 7).

Efforts are underway to determine whether body wetting is correlated with the release of the brain hormone, PTTH, and the phenomenon of gates 1 and 2, in which development is delayed 1 day if the insect has not progressed enough before the onset of the next photoperiod.

Determine source, composition, and endocrine control of "frosted frass" from 5th instar tobacco hornworm - Metabolism and Radiation Research Laboratory, Fargo, ND. Uric acid levels have been determined for various tissues and organs of the tobacco hornworm at selected stages of development for the last larvae instar. During early stages of development of 5th-instar larvae, uric acid synthesized in fat body and/or other tissues has been shown to pass via the hemolymph into the Malpighian tubules where the uric acid concentrates, crystallizes, and is pumped into the gut lumen by the common ampulla. Near the end of the larval feeding period, large quantities of crystalline uric acid covering the surface of the excretion account for the developmental phenomenon of "frosted frass." At the end of the larval feeding stage, the insect "loses" the ability to excrete uric acid via the Malpighian tubules and switches from excretion to storage of uric acid in the fat body. Preliminary experiments have indicated that this switching mechanism occurs at precisely the same time that uric acid is no longer excreted into the hemolymph. These findings suggest hormonal control of synthesis, storage, and excretion of uric acid in insects that undergo a complete metamorphosis.

Hormone interactions in insects - Metabolism and Radiation Research Laboratory, Fargo, ND. The roles of juvenile hormone (JH), neurosecretory material (NSM) and the oostatic hormone (OH) in the maintenance of cyclical egg development were examined. JH activated the ovaries (i.e., made them capable of responding to NSM, which induced vitellogenesis), and that OH prevented NSM release once vitellogenesis was initiated.

Mode of action on chitin biosynthesis of various inhibitors and hormones - Metabolism and Radiation Research Laboratory, Fargo, ND. Some agricultural chemicals (i.e., Dimilin®) may affect chitin synthesis in insects and fungi in different ways, demonstrating that biosynthetic pathways in insects and fungi are not identical. Different compounds have different sites of attack, and synergistic effects are produced when they are combined and tested for inhibition of chitin synthesis. Thus, formulations containing two or more chitin synthesis inhibitors should be evaluated in field experiments.

Involvement of female accessory gland secretion on sperm-egg interaction of house flies - Metabolism and Radiation Research Laboratory, Fargo, ND. Scanning and transmission electron microscopy of house fly sperm acrosomes revealed that treatment of acrosomes with female accessory gland secretion caused disruption of the acrosomal membrane but not removal of the acrosomal membrane material (enzymes) inside. Treatment of acrosomes with a mixture of female accessory gland material plus the micropylar cap substance of the egg resulted in rupture of the acrosomal membrane and also loss of acrosomal material. Thus, the function of the female gland secretion appears to be twofold; it dissociates the acrosomal membrane to expose the acrosomal enzymes and also dissolves the cap substance which covers the micropyle. Material released from the cap substance, in turn, liberates the acrosomal enzymes. Since secretion from the female accessory glands is essential to successful egg fertilization, inhibition of synthesis of this material would provide a means of controlling reproduction in several dipteran pest species.

Preliminary results indicate that the micropylar cap substance of house fly eggs is formed between 50 and 60 hr postemergence when females are held at 26° - 27°C. The origin and function of the "tubular aggregates" found within this cap secretion has not yet been determined. These structures, possibly enzymes, presumably interact with spermatozoa to facilitate sperm entry of the egg.

Attempts at *in vitro* fertilization of house fly eggs were unsuccessful. Sperm combined with mature eggs appeared to enter the external micropyle but were unable to penetrate the underlying vitelline membrane. It appears that unless the acrosomal enzymes are released immediately upon the sperms contact with the egg micropylar cap substance, they are not concentrated enough to alter the vitelline membrane and allow the sperm to enter the ooplasm of the egg. The structure of the fertilization chamber within the female reproductive tract apparently ensures that this timing is synchronized.

Comparison of the effects of removal of female house fly accessory reproductive glands with other dipteran species - Metabolism and Radiation Research Laboratory, Fargo, ND. Tests were conducted to compare the effects of removal of female house fly accessory reproductive glands with that of three other dipteran pest species. Glandless female house flies have been previously shown to be infertile.

The paired glands were removed from the ovipositors of stable flies, face flies, and screwworm flies, and the females subsequently induced to oviposit. In the stable fly, 670 eggs were laid from 22 females, and egg

hatchability was 1 percent. Face fly females were reluctant to oviposit after treatment, but none of the 91 eggs laid hatched after removal of the glands. Screwworm females were likewise infertile as none of 1,575 eggs hatched. Thus, it appears that female accessory gland secretions are essential for egg fertilization in at least one Calliphorid fly (screwworm) as well as in Muscid flies (house fly, stable fly, face fly).

Develop a technique for the observation of pachytene chromosomes of moths - Metabolism and Radiation Research Laboratory, Fargo, ND. Various cytological techniques for chromosome observation were adapted for the pink bollworm and the Mediterranean flour moth allowing the construction of partial pachytene karyotypes of these species. A comparative study of chromosome behavior in prophase of female meiosis in Anagasta and Pectinophora was completed. The two species were found to differ in relative chromosome size, number and structure of nucleolar chromosomes, distribution of constitutive heterochromatin, and behavior of the facultatively heterochromatic Y chromosomes.

Methods for obtaining good pachytene preparations are important for progress in understanding the basic genetics of lepidopterous pest species and will aid in attempts to develop genetic strains with an altered sex ratio or chromosomal translocation and lowered fertility.

Differential radioresistance among strains of the boll weevil - Metabolism and Radiation Research Laboratory, Fargo, ND. Boll weevils collected from cotton fields in the vicinity of Lubbock, Texas; Macon, Georgia; and Jackson, Tennessee, were brought into the laboratory. The radioresistance, based on longevity, was tested for each culture after one generation in the laboratory. Some of the field-collected weevils were crossed so that the resulting hybrids could be tested at the same time as the parental strains and also compared with the Mississippi-Ebony laboratory strain. In addition, the Mississippi-Ebony strain was used in some of the crosses. The crosses proved to be far more radioresistant than the Mississippi-Ebony strain based on (1) LD_{50} - 30 days, (2) LT_{50}'s, (3) mean survival time, and (4) life shortening per 1000 rads. In fact, a majority of the crosses demonstrated heterosis.

Detection of hybrids between the tobacco budworm and a related species found on ground cherry - Metabolism and Radiation Research Laboratory, Fargo, ND. Immunoelectrophoretic studies were carried out to search for serological differences or identities among Heliothis virescens, H. subflexa, and their hybrid progeny. Antibodies to cell-free haemolymph from parents and hybrids of Heliothis moths were elicited in rabbits after subcutaneous injection. Four antisera were produced, one against each sex of H. virescens parental haemolymph (ABvi) and one against each sex of the backcross hybrid (BC-17). The hybrids were produced by the cross H. subflexa females x H. virescens males and thereafter hybrid females x H. virescens males, and yielded sterile males and fertile females by BC-2. After immunoelectrophoresis, 5 to 6 prominent lines of antigen-antibody precipitation are observed. At pH 8.6 and 8.8 the H. subflexa haemolymph, using H. virescens or BC-17 antisera, can be distinguished by a long arc of precipitation in the direction of the cathode that is not characteristic of the hybrid progeny of H. virescens. Subtle differences in precipitation reactions also show promise for distinguishing the hybrids from the parental forms, especially when BC-17 antisera and

fresh, unfrozen haemolymph are used. In addition, when ABvi and haemolymph from H. zea were combined, the precipitation reaction was indistinguishable from that of ABvi vs. haemolymph of H. virescens and Manduca sexta, and the rabbit control sera gave no reaction.

Method for inducing sexual sterility in boll weevils scaled up - Insect Chemosterilants Laboratory, Beltsville, MD, in cooperation with the Boll Weevil Research Laboratory, Mississippi State, MS. Two chemicals were discovered in a synthesis program for inducing sexual sterility in the boll weevil. A fumigation chamber was devised for applying one while the other can be applied by immersion. The fumigation chamber handles 100,000 weevils in 2 hours.

Variety of useful chemicals are discovered in research on metabolism of insect molting hormones - Insect Physiology Laboratory, Beltsville, MD. Studies on biochemical transformations of insect molting hormones have led to the discovery of chemicals which are highly active as (a) acaracides against psoroptic scab mites of livestock, (b) plant parasitic nematodes, and (c) microorganisms which cause mastitis in dairy cattle.

Since these chemicals appear to be fairly inoccuous to higher animals, they will be studied further to determine whether they can be developed to meet pressing needs for acaricides, nematicides, and bactericides. All studies were conducted cooperatively with other SEA/FR laboratories.

Insect growth regulators are found to disrupt vital biochemical transformations of molting hormone - Insect Physiology Laboratory, Beltsville, MD, and Metabolism and Radiation Laboratory, Fargo, ND. Certain insect growth regulators have been shown to exert their effects by disrupting the metabolism of the molting hormone. A tissue culture system was developed in which the mode of action of insect growth regulators can be determined.

Technological Objective 2.

Develop new and improved principles and practices of insect control based on their behavior and ecology.

Research Locations:

1103 Beltsville, Maryland
1108 Beltsville, Maryland
1315 Otis Air Force Base, Massachusetts

Selected Examples of Recent Progress:

Improvements in rearing gypsy moths and in producing the gypsy moth nuclear polyhedrosis virus - Otis Air Force Base, MA. Optimal physical and nutritional conditions for rearing gypsy moths were defined. These findings were used to greatly improve the larval diet, containerization of larvae, and rearing procedures. Consequently, cost of rearing has been reduced to one-third

of previousl levels. Uniformity and synchrony of egg hatch was enhanced through improved egg storage and chilling procedures. Microbial contamination of diets, larval diseases, and worker exposure to insect hair and scales have been eliminated by improved control of environmental parameters, design, and installation of a clean air system, and discovery of effective methods for disinfecting eggs. A prototype rearing and virus production facility is under construction. Production costs of the virus (Gypcheck®) have been reduced to one-fourth of previous levels.

Suppression of reproduction of gypsy moths with the sex attractant - Florist and Nursery Crops Laboratory, Beltsville, MD. The sex attractant, racemic disparlure, was deployed in plastic sandwiches (hercon dispensers) stapled to trees in a 10m x 10m grid. In sparse populations, matings which resulted in sperm transfer were reduced by 70 percent and egg viability was reduced by 98 percent. This difference between percent mating and percent egg hatch is probably caused by the fact that the sex attractant greatly increases the time required for males to locate females. Apparently, many females have begun to lay eggs by the time they are mated. In such females sperm do not fertilize the eggs.

Field studies conducted in cooperation with the Organic Chemicals Synthesis Laboratory, Beltsville, Maryland, also showed that the (+)-enantiomer is tenfold more attractive than racemic disparlure, but both materials are equally effective in mating disruption.

Tobacco budworm males produce pheromone which inhibits release of sex attractants by females - Biologically Active Natural Products Laboratory, Beltsville, MD. Tobacco budworm males produce a pheromone from their hair pencils which suppresses the release of the sex attractant by females. Studies undertaken in cooperation with SEA/FR scientists at Oxford, North Carolina, have shown that the male pheromone is perceived by the female's antennae. Efforts to purify and identify the male pheromone are underway.

New plant attractants for Mediterranean fruit fly males and females - Biologically Active Natural Products Laboratory, Beltsville, MD. Cooperative studies with SEA/FR, Honolulu, Hawaii, showed the attractant in Lepidium virginicum to be linoleic acid.

Sex attractant of Mediterranean fruit fly males identified - Biologically Active Natural Products Laboratory, Beltsville, MD. Cooperative studies with SEA/FR, Honolulu, Hawaii, established the Mediterranean fruit fly sex attractant to be methyl(E)-6-nonenoate.

Sex pheromone pilot plant established - Biologically Active Natural Products Laboratory, Beltsville, MD. Under the auspices of the United States/Israeli Binational Research Foundation, and in cooperation with the Israel Ministry of Agriculture, an improved synthesis method was developed for the sex pheromone of the cotton leafworm. Based on this research, a pilot plant has been established in Beersheba, Israel. The pheromone is useful both to survey for the pest and to suppress it.

Highly active insect feeding deterrent identified in neem seed - Biologically Active Natural Products Laboratory, Beltsville, MD. A compound identified as azadirachtin was identified from neem seed. Field tests showed that this material can be used to protect soybean and sassafras from Japanese beetles.

Promising candidate repellents synthesized for German cockroaches, mosquitoes, and blackflies - Organic Chemicals Synthesis Laboratory, Beltsville, MD. These candidate repellents were synthesized which provide 100 percent repellency to German cockroaches for 2 to 3 weeks. Promising candidate mosquito repellents were made available for toxicology tests to the U.S. Army Environmental Health Agency, Aberdeen, Maryland. Several repellents were synthesized which appear to be more effective against blackflies than diet.

Progress in isolating and identifying sex attractants of corn earworm, citrus mealybug, and other insects - Organic Chemicals Synthesis Laboratory, Beltsville, MD. Capillary column gas chromatography revealed that a heptane wash of ovipositors of corn earworm females contained the following four components (Z)-11-hexadec-enal(96%), (Z)-9-hexadecenal (1.3%), (Z)-7-hexadecenal (0.7%), and hexadecenal (2%). Mixtures of the components were highly attractive to males in the field.

Considerable progress was made in identifying the sex attractants of the Comstock mealybug and of the citrus mealybug. Some progress was made in isolating the pheromone of the carrot beetle, the sunflower moth, and of the Gulf Coast tick.

Successful formulation developed for screwworm attractant - Organic Chemicals Synthesis Laboratory, Beltsville, MD. A semisolid formulation of swormlure-2, the screwworm attractant was developed to overcome its corrosive properties and offensive odor. Apparently, this formulation will be adopted by the Animal and Plant Health Inspection Service.

Technological Objective 3.

Develop new and improved principles and practices in insecticide use.

Research Locations:

1103 Beltsville, Maryland

Selected Examples of Recent Progress:

Toxicity of sunflower seeds to fall armyworm is caused by linoleic acid - Biologically Active Natural Products Laboratory, Beltsville, MD. A number of plant extracts were evaluated for antijuvenile hormone activity on the fall armyworm. The toxic extract of sunflower seeds was shown to consist of linoleic acid.

Promising new selective insecticides are evaluated and pesticide data base is being computerized - Chemicals Coordination Unit, Beltsville, MD. During calendar 1977, SEA/FR received 50 new chemicals from 14 industry research laboratories for evaluation as insect control agents - 31 as insecticides, 13 as growth and development inhibitors, and 6 as repellents. As evidence of selective testing, only 8 of the 50 were evaluated in more than one laboratory. Seventy samples of compounds previously received were tested for additional uses. Work was continued on the construction of a pesticide data base to use computer-assisted techniques for the recognition and design of improved insect control chemicals. New software for an optical scanner was installed and is operating smoothly. This will facilitate the capture of research results from field locations by means of typewritten copy. Chemical records on 40% of a file of 8,000 plant growth regulators were computerized. Results of screen-testing on 1,050 nematicides and 2,677 insect growth regulators were edited and specifications written for key-punching by contract. In a structure-activity study against the fire ant, 2,750 test chemicals were coded into Wiswesser line notation and permuted by computer on selected chemical fragments in order to determine their frequency of occurrence in active vs. inactive compounds. Little or no activity is associated with quaternary and other ionic ompounds, carboxylic acids, aldehydes, ketones, thiones, sulfones and alcohols. A projection as to what an active structure might include has since been corroborated in at least one new series of compounds.

Analogues of diflubenzuron (Dimilin®) prevent egg hatch in the large milkweed bug - Biological Evaluation of Chemicals Laboratory, Beltsville, MD. Twenty-four analogs of Dimilin® were applied to adult milkweed bugs at 10 micrograms per insect. Of these, four reduced egg hatch and/or development.

Control of fly larvae in chicken manure - Analytical Chemistry Laboratory, Beltsville, MD. An encapsulated formulation of Dimilin® in modified cellulose when incorporated into chicken feed controlled fly larvae in chicken manure without significant residues in chicken tissues and eggs.

Prediction of molecular structure of a Mirex metabolite - Analytical Chemistry Laboratory, Beltsville, MD. NMR spectra established the exact molecular positions of chlorine and hydrogen atoms in a potential toxic metabolite of Mirex.

Terramycin in honey - Analytical Chemistry Laboratory, Beltsville, MD. A study was made to minimize the amounts of terramycin residues that appear in the honey of bees that have been treated with the antibiotic.

Automation of extraction and cleanup procedures for pesticide residues - Analytical Chemistry Laboratory, Beltsville, MD. Technicon Autoanalyzer modules assembled for automated extraction, filtration, and cleanup chromatography show that multiple sample analysis reduces cost and increases reliability.

WHO adopts 2 percent d-phenothrin for disinsecting aircraft - Chemical and Biophysical Control Laboratory, Beltsville, MD. The International Sanitary Regulations of the World Health Organization now include the use of the formulation containing 2 percent d-phenothrin in Freon 11+12 (1:1) for disinsecting aircraft. This highly effective treatment leaves no odor which was a drawback to an earlier pyrethroid formulation.

Alternatives to DDT in aircraft disinsection against Japanese beetle are recommended - Chemical and Biophysical Control Laboratory, Beltsville, MD. The 85 percent carbaryl on Hi Sil 233 dust at a dose of 1 g/1000 ft^3 is in the current APHIS manual for aircraft treatment in certain areas to prevent the spread of the Japanese beetle. The 10 percent d-phenothrin aerosol at 5 g/1000 ft^3 has been approved by EPA for the treatment of aircraft against the Japanese beetle. APHIS now has good alternative treatments should court action result in the banning of DDT.

Controlled release formulation of methoprene in biodegradable polymer prevents emergence of cattle heel fly; controlled release preparation prolongs efficience of famphur in tick control - Chemical and Biophysical Control Laboratory, Beltsville, MD. Pellets which contained controlled release formulations of methoprene in poly(d,l-lactic acid) which injected into infested cattle prevented emergence of adult heel flies (Hypoderma sp.). A microencapsulated preparation containing famphur prolonged efficiency of this compound in systemic control of cattle ticks (Amblyomma sp.)

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National Research Program 20260

BIOLOGICAL AGENTS FOR PEST CONTROL

This National Research Program (NRP) describes the status and prospects for Federal research on biological control of pests and insect taxonomy in the U.S. One objective of this NRP is the exploration, evaluation, importation, and establishment of exotic natural enemies of a wide variety of pests, primarily introduced species, affecting U.S. crop production. Another objective involves two additional aspects of biological control, the augmentation and conservation of native and introduced natural enemies for control of agricultural pests. In addition, this NRP is concerned with the identification and classification of insects and mites as related to pest management and in support of research and regulatory responsibilities of Federal and State agencies and other institutions.

NPS Contact: D. E. Bryan PACS Contact: M. T. Ouye

Technological Objective 1.

New and improved technology for discovery and evaluation of biological agents in foreign countries and introduction for control of insects, weeds, plant pathogens and other pests.

Research Locations:

5209	Albany, California
1213	Newark, Delaware
7602	Gainesville, Florida
1111	Beltsville, Maryland
1208	Frederick, Maryland
3402	Columbia, Missouri
7307	Temple, Texas
0203	Hurlingham, Argentina
0203	Sevres, France
0203	Sapporo, Japan
0203	Rome, Italy

Selected Examples of Recent Progress:

Moth larvae reduced Russian thistle in California - Albany, CA. *Coleophora parthenica* moths introduced from Pakistan have spread over 15,000 acres. Population levels of 3-15 larvae/meter of plant stem have resulted in significant reduction in weed seed production. Further distribution of the moths is being accomplished with the cooperation of the California State Departments of Transportation and Food and Agriculture, and several county departments of agriculture which ordinarily spend $1.5 million annually for control and clean up of the weed.

Beetles introduced from Italy destroyed stands of tansy ragwort in northern California - Albany, CA. Larvae of Longitarsus jacobaeae which averaged 265/plant rosette caused the death of most of the toxic range weed at release sites. Beetles were also recovered from 60 of 80 release sites in Oregon.

Biological control agents from 16 countries were processed through quarantine for control of serious pests of crops and forests - Newark, DE. A total of 82 species (105,000 individuals) were cleared and distributed in 409 shipments to research workers in 26 States and 2 Canadian provinces. From these shipments, 31 species were released for control of aphids, alfalfa blotch leafminer, lygus bugs, alfalfa weevil, gypsy moth, European cornborer, and larch casebearer.

Parasites provided excellent control of the alfalfa weevil over most areas of the northeastern U.S. - Newark, DE. Parasitism caused by beneficial insects introduced from Europe continues the estimated $5 million annual savings from reduced infestations. Approximately 34,000 parasites were distributed to 11 mid-western States where the alfalfa weevil is a serious pest.

Improved system installed for documenting introduction of beneficial organisms to U.S. - Beltsville, MD. Standardized "Biological Shipment Record" forms (ARS forms 441, 442) were conceived, printed and distributed for use by all FR overseas and domestic quarantine locations involved in shipment and receipt of foreign beneficial organisms. Such documentation is essential for orderly assessment of accomplishments in biological control.

Plant pathogen introduced from Europe reduced rust skeletonweed in the Western U.S. - Frederick, MD. Uredospores of the rust, Puccinia chondrillina, released in California, Idaho, and Oregon have provided infection in at least 25 percent of all release sites. In California, the rush reduced weed populations within the study areas by one-third in 1977. Skeletonweed races in far eastern Washington and northern Idaho were not susceptible to any of 79 strains of the rust currently collected.

Imported velvetbean caterpillar parasite established - Columbia, MO. A parasite (Euplectrus n. sp.) obtained from S. America and released in Southern Florida in 1976 has become established for control of this major pest of soybean.

Exploration for biological control agents which attack several important pests successfully - Sevres, France. Twelve parasites of the alfalfa blotch leafminer, a new pest in the northeastern U.S., have been discovered in Europe and sent to the Newark, DE laboratory for distribution. A fly parasitic on the pine adelgid has been shipped to Hawaii where it is now established. Three species of Peristenus and two species of insect parasitic nematodes were recovered from lygus bugs in southern, central, and western France, Germany, and Austria for release in the U.S. Other beneficials shipped to the U.S. included aphid parasites, southern pine beetle predators, and grasshopper parasites.

Exploration for biological agents which control weeds successfully - Rome, Italy. Seventeen shipments comprising over 7,600 plant-feeding insects discovered in Europe were shipped to quarantine locations for control of nine different weed species in the U.S.

Successful exploration for beneficial insects in Asia - Sapporo, Japan. Parasites and predators of several pests were discovered and shipped to receiving laboratories in the U.S. These included six natural enemies of the gypsy moth and one for control of the chestnut gall wasp in Georgia.

Technological Objective 2.

New and improved technology for increase and conservation of introduced and native biological agents for control of insects, weeds, plant pathogens and other pests.

Research Locations:

7702	Tifton, Georgia
3102	Peoria, Illinois
1313	Orono, Maine
1110	Beltsville, Maryland
3402	Columbia, Missouri
7203	Brownsville, Texas
7302	College Station, Texas

Selected Examples of Recent Progress:

Kairomones significantly increased parasitism of corn earworm by egg parasite - Tifton, GA. Several chemicals, which mediate the behavior of parasites in finding hosts, were identified, synthesized and their mechanisms of activity defined. In experimental studies the application of kairomones in the proper dosage and pattern increased the effectiveness of Trichogramma thus demonstrating a means of better utilization of natural enemies in pest management.

Development of Entomophthora for spruce budworm control - Orono, ME. Mono-conidial isolates of E. sphaerosperma were obtained in pure culture. They were pathogenic to spruce budworm and produced resting spores in large numbers both in infected budworm and in solid media. This will permit appraisal of the genetic stability of isolates for the first time. Contrary to previous field observations, E. sphaerosperma can infect all larval instars, pupae and adults of both sexes. Isolates from Israel, France, and Maine proved infective to the budworm.

Insect virus isolated - Beltsville, MD. New virus-like particles, similar morphologically but smaller than rhabdoviruses, have been isolated from crickets in Tennessee and Mexican bean beetle in Maryland. These pathogens exhibit different morphologies than any other animal or insect virus previously reported and may have potential for biological control.

New serum-free culture medium for insect cells - Beltsville, MD. A serum-free tissue culture medium was developed for the first time which supports continuous growth of cell lines of gypsy moth. This accomplishment will allow investigation of insect cell nutritional requirements and pathology studies with obligate intracellular insect pathogens. It may also allow the future development of economically feasible *in vitro* production methods for viruses used for pest control.

Development of a fungus as a microbial insecticide - Columbia, MO. The fungus, *Nomuraea rileyi*, which is pathogenic to several caterpillar pests has been demonstrated safe for beneficial insects and humans. These results will contribute to the future use of the fungus as a pesticide.

Sunlight inactivation of microbial insecticides - Columbia, MO. Laboratory studies indicate that sunlight inactivation, which is believed to be the major environmental factor in reducing effectiveness of microbial insecticides, is probably caused by peroxide or peroxide radicals produced by irradiation of amino acids. These results may lead to development of microbial formulations with significantly increased field persistence.

Improvements in activity of *B. thuringiensis* - Brownsville, TX. In cooperation with 15 scientists in the U.S. and in foreign countries, the spectra of activity of 319 *B. thuringiensis* isolates have been determined against 24 different insect species. Although the standard, HD-1, appears to have the broadest activity spectrum against the largest number of susceptible species, in almost all insects studied one or more additional isolates have been identified which have higher activity for individual species.

Improved formulations of microbial pesticides - College Station, TX. Protective formulations of *Heliothis* nuclear polyhedrosis virus were made by incorporating the pathogen with ultraviolet light-screening agents in solid microcapsules bound with a digestible, water-insoluable polymer. The encapsulated preparations of virus containing carbon black or titanium oxide were highly tolerant of solar or artificial radiation; biological activity was greater than that of existing commercial formulations. Effectiveness against *Heliothis* spp. in cotton was comparable to that of a standard insecticide. The manufacture of the encapsulated formulations is economically feasible; they have potential use in improving field persistence of any insecticidal pathogen.

Technological Objective 3.

New and improved principles and practices of insect and mite identification.

Research Location:

1111 Beltsville, Maryland

Selected Examples of Recent Progress:

Scientific names in corn earworm genus listed - Beltsville, MD. The 154 species-group names in the corn earworm genus Heliothis were listed and annotated with geographic distribution, citation to original description and published illustrations of diagnostic features. This information will provide an information base essential for biological and other types of control programs.

Potential New World biological control agents (flies and braconid wasps) of corn earworm complex defined - Beltsville, MD. Eighty parasitic fly and wasp species of the corn earworm and allies in the Americas were cited. Known hosts and geographic distribution of the parasites and a key to the wasps provide a list of candidate biological control agents.

Seed weevils attacking mesquite defined - Beltsville, MD. Definition of the 15 kinds of Mimosestes beetles, association of larval food plants, and determination of geographic distribution were completed. This will allow biocontrol workers to proceed with research on two candidate species for control of mesquite in the southwestern U.S.

Identities of two leaf beetles clarified - Beltsville, MD. Biosystematic research showed that two species of leaf beetles (Lema) had been mistaken as a single entity. One (Lema trilineata) can be a minor pest of potatoes; the other, L. trivittata, will not feed on potatoes. Control measures would be unsuccessful or unwarranted without this recognition.

Computerized catalog of North American ants, bees, wasps and sawflies completed - Beltsville, MD. Information on geographic distribution, hosts, prey, predators, parasites, pollen and nectar sources, and literature references for more than 17,000 species in this important order of insects is available for the first time in a data matrix that can be queried in several different ways. It will be particularly useful for biocontrol workers in the U.S.

Identification aid to fruit flies prepared - Beltsville, MD. An illustrated key to 155 species of the genus Anastrepha will permit quick recognition of those important pest species at U.S. ports of entry. Such rapid identification could save millions of dollars in remedial costs by allowing early evaluation of need for control.

Service function of Systematic Entomology Laboratory - Beltsville, MD. In fulfillment of the service function which the laboratory is unique in providing the Nation, 53,443 identifications were made from 256,193 specimens for Federal, State and private organizations in support of their research and regulatory programs.

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National Research Program 20270

CROP DISEASE CONTROL AND NON-COMMODITY RESEARCH ON PLANT PATHOGENS AND NEMATODES

This National Research Program involves basic, fundamental research which is non-commodity oriented, aimed at reducing losses in agricultural production due to diseases and nematodes. It includes research in the areas of nematology, virology, mycoplasmas, mycology, soilborne diseases, exotic plant diseases, and the nature of disease resistance. Scientists in this program seek new knowledge concerning biology, morphology, genetics, virulence, and resistance mechanisms of nematodes and causal agents of plant diseases. Systems are developed which put together the most effective combination of resistant varieties, cultural practices, and control measures to provide maximum yield and quality with minimum undesirable effects on the environment.

NPS Contact: W. M. Dowler PACS Contact: M. T. Ouye

Technological Objective 1:

Acquire fundamental knowledge and develop basic concepts relative to plant diseases, nematodes, and causal agents.

Research Locations:

5203	Shafter, California
7706	Byron, Georgia
3311	Urbana, Illinois
7413	Baton Rouge, Louisiana
1110	Beltsville, Maryland
1208	Frederick, Maryland
3502	St. Paul, Minnesota
5708	Bozeman, Montana
1307	Ithaca, New York
7711	Charleston, South Carolina
3608	Brookings, South Dakota
7302	College Station, Texas
7313	Lubbock, Texas
5702	Logan, Utah
7619	St. Croix, Virgin Island
3090	Madison, Wisconsin

Selected Examples of Recent Progress:

Virology:

Viroids similar to potato spindle tuber virus isolated from Solanum sp. in germplasm collections - Beltsville, MD. Viroids have been isolated from a significant number of germplasm selections maintained at the USDA Potato Introduction Station, Sturgeon Bay, WI. This demonstrates that viroids may be present in germplasm collections which have passed through Quarantine and that they are present in plants grown from true seed as well as vegetatively propagated material.

DNA complementary to potato spindle tuber virus (PSTV) synthesized in vitro - Beltsville, MD. This was accomplished using an enzyme extracted from a chicken virus. This provides an important tool for the study of the relationship among viroid species and for the identification of viroids in plants without obvious symptoms. The information can also be used to determine how closely any viroid detected is related to PSTV.

New mycoplasmas and spiroplasmas isolated from nectar-bearing flowers - Beltsville, MD. This demonstrated for the first time that pathogenic spiroplasmas can survive outside living host tissues. These agents were able to grow at 37°C, thus uncovering an unexpected reservoir of cell wall-free prokaryotes potentially capable of infecting vertebrates.

Cucumber mosaic virus-associated RNA 5 found in several different CMV isolates - Beltsville, MD. These isolates originated in very different parts of the world. Another satellite-like RNA was found in peanut stunt virus. All cause tomato necrosis in the presence of CMV.

Electron Microscopy - Beltsville, MD. Electron micrographs of crystals of tobacco mosaic virus freeze-fractured and freeze-etched in the presence of different amounts of cryoprotectants have provided data to permit the construction of a model of these crystals. Ice crystals form within the TMV crystals if proper concentration of cryoprotectants is not provided for the freezing conditions used.

Ultra-cold storage of maize streak virus - Frederick, MD. Maize streak virus was purified and stored in the gaseous phase of a liquid nitrogen refrigerator. Insect vectors can acquire the virus from a suspension removed from storage and thawed quickly. This technique enables researchers to store "type" virus inocula over extended periods of time.

Relationships among barley yellow dwarf virus and beet western yellows virus - Ithaca, NY. Serological studies in cooperation with Dr. J. Duffus, Salinas, CA, showed that these two viruses are closely related. They share similar protein composition, overlapping of aphid vectors, and a similar host plant range. Previous views of these diseases may have been too narrowly restricted, and this relationship may have a special significance in the epidemiology of these luteoviruses.

Maize chlorotic mottle virus present in corn rootworm beetles - Brookings, SD. The virus was recovered from about 16% of the beetles collected from virus-infected fields in Nebraska. Transmissions of this virus have been erratic and apparently depend on conditions of the beetles and conditions of the test. In addition, we have what appears to be larval transmission of this virus.

Soilborne Diseases:

Discovery and characterization of a new beneficial mycoparasite - Beltsville, MD. A new mycoparasite of Sclerotinia sclerotiorum, an important soilborne pathogen from bean, lettuce, celery, peanut, and other crops was isolated and characterized. The new fungus, named Sporidesmium sclerotivorum, parasitized and destroyed sclerotia (infective propagules) of the plant pathogen in natural soils within 13 weeks in laboratory experiments. The specificity of parasitism and the unique ability of this fungus to grow profusely through soil from one plant pathogen propagule to another indicates that this unusual fungus may have great potential as an effective biocontrol agent in reducing plant diseases.

Mobility of fungicides in plants grown from seeds treated with fungicides - Beltsville, MD. Fungicides were applied directly to cottonseed or with the organic solvent infusion technique using acetone as solvent. With either method of application, most of the fungicide was in the seed coat. However, more fungicide was found in the embryo in seeds treated with the solvent infusion technique. Fungicides in seeds treated with the organic solvent infusion method were not leached out as readily as those applied directly to the seeds, but there was limited movement in growing parts of the plants.

Involvement of toxins in fungal pathogenicity - Beltsville, MD. Oxalic acid, a toxic metabolite of Sclerotinia sclerotiorum, was detected in abundant quantities in ethanol extracts of mycelium produced in culture. The acid, which is thought to poison host cells in advance of the fungus, was also associated with hyphal tips of the fungus, thus verifying the suspected role in pathogenicity.

Nematology:

Mode of action of carbamate nematicides - Salinas, CA. Sugarbeets grown 21 days in soils treated with aldicarb contained residues of aldicarb in roots and foliage proportional to applied rates. Development of sugarbeet cyst nematodes was decreased on root slices proportional to the concentration of total aldicarb residues in roots. Greater amounts of aldicarb were required to suppress development of males.

Resistance in soybeans to lesion nematodes - Urbana, IL . Evaluation of 51 soybean cultivars in varying maturity groups demonstrated a wide range of susceptibility to the lesion nematode. The determination of sources of resistance in existing cultivars offers growers some immediate degree of control and will aid in the initiation of breeding programs to develop new resistant cultivars.

Biological control agent affected by soil chemicals - Baton Rouge, LA. A beneficial protozoan, Duboscqia penetrans, that parasitizes nematodes was apparently destroyed in the soil by the application of nematicides, a fungicide, and antibiotics. Numbers of root-knot nematode larvae were greatly increased when the antibiotic streptomycin was applied, apparently because the protozoan parasites were killed. Field application of some soil chemicals may account for nematode population increases that often occur about three months after soil treatment.

Unique feeding plug observed in soybean roots infected by the soybean cyst nematode - Beltsville, MD. Soon after inoculation a pluglike deposit was observed between the stylet of the nematode and the cell wall of the host. During the feeding process, the plug appeared to form a seal between the stylet wall. The plug is probably formed from a combination of nematode secretions and cell wall deposits.

A new lesion nematode parasite of corn and soybeans - Beltsville, MD. The lesion nematode Pratylenchus agilis parasitizes three soybean cultivars in Maryland and will reproduce readily on corn, a new host, which is often used in rotation. Soybean yields have been increased 10 to 30% following nematicide treatment.

New kind of root-knot nematode identified in Louisiana - Beltsville, MD. A root-knot nematode heavily damaging all soybean varieties available to Louisiana growers has been found to be a new form. Previously this nematode was thought to be a variant of the common root-knot nematode, but recent laboratory studies have shown that it is different. This will aid in the development of resistant soybean varieties or determination of non-host crops which can be used when the nematode is present.

New approach for chemical control of nematodes - College Station, TX. Chitin synthetase inhibitors applied to seed or soil, or fed to free-living nematodes, have reduced the reproduction of associated nematodes. There was no effect on larval or adult stages, and chitin synthetase appears to be critical only to nematode reproduction. This is probably because chitin is localized only in the eggshell. Development of this concept of nematode control could lead to new and improved methods for controlling nematodes.

Use of a nematode for biological control of silverleaf nightshade - Lubbock, TX. Parasitism of the weed silverleaf nightshade by the nematode Nothanguina phyllobia gave 90% control of the weed after three years. The nematode is readily introduced by spreading dry crushed infected tissue on the soil. The nematode can overwinter in the soil and travel to any part of a plant in a few hours.

Burrowing nematode in Texas not citrus race - Weslaco, TX. The burrowing nematode found recently in Texas is believed not to be the race that devastates citrus in Florida. The population found in Texas is the banana race which will not attack citrus. Therefore, this nematode appears not to be a threat to the Texas citrus industry.

Pathogenicity of sugarbeet nematode affected by plant age/nematode density - Logan UT. Differences in nematode population density were more important on younger plants than on older plants. In the field, early planted sugarbeets tolerated a higher nematode population density at temperatures below 10C compared with similar plantings above 10C. This underscores the importance of determining economic threshold population densities for each sugarbeet production area.

Mycology:

Mycology laboratory moves into new facilities - Beltsville, MD. Research laboratories, the herbarium, technical information facilities, and offices of the mycology laboratory moved into new facilities at the bioscience building, BARC-W. The added space and better arrangement of laboratories, offices, collections, and library notably improves the research facilities.

Life history completed on Zopfia rhizophila - Beltsville, MD. This pathogen on asparagus roots was studied and the complete life history revealed. This is the first time the systematic position of any fungus in the family Zopfiaceae has been determined by study of its development and cytology.

Black mildew fungi - Beltsville, MD. A taxonomic study of 30 species of black mildew fungi was completed. This resulted in a major taxonomic reclassification and in the recognition of two new subgenera, a new species, and a new variety.

Survey and identification of lawn fungi - Beltsville, MD. During 1977, 150 collections were obtained from lawns in the Beltsville area. The genus Stropharia was emphasized which includes toxic species encountered in lawns. A unique vegetative structure is characteristic of this genus and may aid in identification of this mushroom.

Exotic plant diseases:

Specific resistance found to soybean rust - Frederick, MD. Two soybean accessions show specific resistance to soybean rust cultures. Commerical U.S. soybean varieties currently lack resistance to soybean rust strains from the Orient. Incorporation of this rust resistance into desirable, high-yielding U.S. varieties could be of enormous potential benefit to soybean producers, processors, and consumers if soybean rust enters the U.S.

Identity and interrelationships of downy mildews of corn and sorghum - Frederick, MD. Mycological studies of several species of downy mildew grown on the same maize cultivar and under the same environmental conditions produce conidiophores and conidia which differ in size and shape. Results indicate that the pathogens studied are indeed different species.

Biology of corn rust - Frederick, MD. Corn plants were uniformly inoculated with Puccinia polysora, causal agent of corn rust. Plants held at warm day/night temperature produced many more spores than did plants held at cool day/night temperature, but plants at the cool temperatures produced spores over a longer period of time. Results indicate that corn rust could be a significant problem in most corn producing areas of the United States.

Stimulation of germination of fungal propagules - Frederick, MD. Marked synergism of activity on germination of conidia of Penicillium digitatum was noted with mixtures of nonanal and citral. This is the first time synergism between compounds has been observed with volatile spore stimulators, and suggests that mixtures of compounds may be necessary to stimulate certain propagules.

Nature of Resistance:

Bioassay for detecting possible determinants of specificity in gene-for-gene host-parasite interactions - St. Paul, MN. A procedure was developed for microinjection of cells to study mechanisms of resistance. Optimum experimental conditions were established for expression of hypersensitive cell death due to a specific gene in mildewed tissues so that similar conditions could be used in microinfection assays. Incompatibility was expressed at several stages in host-parasite interaction, suggesting that gene-for-gene incompatibility disrupts host-parasite interaction continuously instead of in only one stage of infection.

Studies of inheritance of resistance to Septoria in wheat - Bozeman, MT. Gaines and losses of resistance in progeny of wheat crosses were measured through five generations. Step-wise increases in resistance among selected progeny were determined. Some progeny exhibited significantly fewer lesions per unit area than either parent, but necrosis was intermediate.

Effect of an inhibitory factor in corn extracts on resistance to bacterial leaf and stalk rot - Madison, WI. The hydroxic acid termed DIMBOA is the major factor in extracts of corn inhibitory to soft rotting Erwinia spp. The correlation between pathogenicity of corn isolates and insensitivity to DIMBOA was highly significant, but this correlation did not exist with non-corn isolates. It was concluded that DIMBOA in corn presents a strong selection pressure for potential pathogens of corn.

Nature of resistance of tobacco plant cell - Madison, WI. Tissue cultures continue to be extremely useful for studying the nature of resistance. Race specific recognition of pathogen and nonpathogen have been achieved by tissue cultures. Tissue cultures elaborate certain fungal inhibitors when challenged by the fungus, and the chemical identity of one of these inhibitors is the same as the one produced by plant leaves challenged with the same fungus.

Ice nucleation active bacteria and frost sensitivity of plants - Madison, WI. INA bacteria have been isolated from over 60 species of plants from several states. Application of bactericides and ice nucleation inhibitors decreased the amount of injury from natural frost under field conditions. Measurable protection has been achieved on beans, tomatoes, corn, potatoes, and squash.

Technological Objective 2.

Develop systems for economical control of plant diseases and nematodes with maximum beneficial effects on yields and quality, and with minimum undesirable effects on the environment and public health.

Research Locations:

5205	Salinas, California
5203	Shafter, California
7607	Orlando, Florida
7706	Byron, Georgia
7702	Tifton, Georgia
3311	Urbana, Illinois
7413	Baton Rouge, Louisiana
1110	Beltsville, Maryland
1208	Frederick, Maryland
3502	St. Paul, Minnesota
5708	Bozeman, Montana
1307	Ithaca, New York
7711	Charleston, South Carolina
7808	Jackson, Tennessee
7313	Lubbock, Texas
7207	Weslaco, Texas
5702	Logan, Utah

Selected Examples of Recent Progress:

Four new breeding lines of cotton jointly released with high resistance to cotton root-knot nematode - Shafter, CA . These breeding lines were developed in cooperation with the California Agricultural Experiment Station, and nematode infection ratings for the new material were much lower than for Acala SJ-2. The breeding lines have varying fiber qualities, but are generally equal to Acala SJ-2. They all mature later and grow taller.

Combined bioenvironmental and cultural practices improve nematode control in citrus - Orlando, FL. Improved management of irrigation practices plus a nematicide for control of the burrowing nematode on citrus trees resulted in a 61% increase in yield compared to untreated trees.

Field trials compare fumigation and addition of lime for control of ring nematodes - Byron, GA. Host plant fumigation with the nematicide DBCP or the addition of 5.5 kg of hydrated lime per tree site resulted in approximately 5% tree loss compared with over 60% loss in nontreated plots.

Development of production systems for high value vegetable crops - Tifton, GA. A system utilizing film mulch, broad-spectrum soil fumigants, and trickle irrigation incorporating fertilization has been developed for production of high value vegetable crops. Yields of cucumber and summer squash were increased 3-4 times over the yields considered normal in Georgia.

Crop rotation suppresses root-knot nematodes - Tifton, GA. Integrated pest management studies with intensive cropping systems demonstrated that populations of root-knot nematodes were suppressed with some systems but increased in others. This information is beneficial to aid growers in selecting crops that are not favorable hosts for nematodes.

Peanut yields increased with nematicides and a fungicide - Tifton, GA. Peanut yields were increased 500-1000 lb per acre when selected nematicides were combined with a fungicide and applied to peanuts at pegging time. Yield increases resulted from both nematode and white mold control.

Relationship of planting date of soybeans to nematode damage - Urbana, IL. Earlier planting (May 5-June 1) of either nematode susceptible or resistant soybean varieties resulted in significantly increased yields compared with plantings after mid-June.

Resistant soybean cultivar increases production and shows carry-over effect - Baton Rouge, LA. When Pickett 71 soybean, resistant to reniform nematode, was planted in rotation with a susceptible soybean and cotton cultivar, the susceptible soybean and cotton produced significantly more following the resistant Pickett cultivar in rotation. The increase caused by growing the resistant variety was as great as increases provided by soil fumigation.

A few ounces of fungicide per acre reduces bean blight - Beltsville, MD. Improved snap bean stand and reduction of Pythium blight were accomplished in the field by applying certain systemic fungicides to bean seed with the organic solvent infusion method. This disease is not controlled by conventional seed treatment or any other means. Only 2-5 ounces per acre are needed to control the disease.

Plowing reduces an important soilborne plant disease - Beltsville, MD. Root rot of bean and belly rot of cucumber caused by Rhizoctonia solani was appreciably reduced in the field in two consecutive years by plowing the residues to a depth of 8 to 10 inches with a moldboard plow before planting beans or cucumbers. This provides a method for reducing a serious disease on two crops without large amounts of pesticides for which there are currently no effective control measures. This information may be especially beneficial to small farmers and other farmers that grow these crops.

Epidemiology of corn viruses - Frederick, MD. Epidemiology of maize dwarf mosaic virus and maize chlorotic virus was studied to determine means of virus spread. The largest populations of the specific aphids which transfer the respective viruses coincide with the most rapid spread of the virus. This was a better indicator of virus spread than weekly trap plant assays.

Improved oat cultivar released - St. Paul, MN. "Lyon" was released which outyields the current most popular cultivars in Minnesota. Superior qualities include lodging resistance, crown rust resistance, and smut resistance. "Lyon" is a spring oat developed cooperatively with the Minnesota Agriculture Experiment Station.

Barley diseases - Bozeman, MT. The principle barley leaf disease where malting barley is grown under irrigation is net blotch caused by Helminthosporium teres. Other leaf diseases are also present, and disease losses increase where minimum tillage and continuous barley cropping are practiced.

Management of golden nematode of potato - Ithaca, NY. Monoculture of a resistant cultivar was the best system for maintaining nematode densities at extremely low levels. Resistant and susceptible cultivars grown in alternate years or a three year alternation of resistant, susceptible, and nonhost crop maintained densities at levels where there was not evidence of spread of nematode cysts on tubers, provided the recommended pesticide is used with the susceptible cultivar. Systems with less stringent control strategies did not effectively manage densities below spread level.

Snap bean breeding lines resistant to root-knot nematode - Charleston, SC. Four snap bean breeding lines have been developed with resistance to root-knot nematode. Incorporation of this resistant material into commercially desirable cultivars can result in improved yields without additional use of pesticides.

New soybean cultivar released - Jackson, TN. A new soybean cultivar named "Bedford" with a high level of resistance to Races 1, 3, and 4 of the soybean cyst nematode, root-knot, and reniform nematode was jointly released in October 1977. Field tests in several southeastern states indicate yields in most cases were considerably higher than cultivars normally planted in the area.

Chemical control of nematodes in cotton - Lubbock, TX. The efficacy of several nematicides as well as methods of application was evaluated. Results showed that conventional injection of soil fumigants gave the best nematode control with greatest yield increases. Systemic or contact nematicides gave variable nematode control. Shallow injection of soil fumigants at planting is less effective than deep injection preplant treatments.

Importance of nematode population densities - Logan, UT. The rate of chemical needed for obtaining optimum sugarbeet yields is closely correlated to initial nematode populations. It is a complex system because of the need for proper soil sampling techniques, nematode extraction, and interaction with factors such as soil type, soil temperatures, soil moisture, and other pesticides used. This is an area of research which needs to be incorporated into a model to aid in determining proper chemical applications.

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National Research Program 20280

WEED CONTROL TECHNOLOGY FOR PROTECTING CROPS, GRAZING LANDS, AQUATIC SITES, AND NONCROPLAND

This multidisciplinary national research program deals with the development of principles of weed science and safe and efficient principles and practices of weed control that can be integrated with other production and protection technology into weed management systems. This research is essential to the development of high-yielding food, feed, and fiber agroecosystems that will maintain the Nation's food supply and improve the quality of the environment. It supports the missions and goals of SEA and the Department. This program is organized into 122 projects at 45 locations, and is conducted by 64 SEA scientists in cooperation with several Federal agencies, State agricultural experiment stations (SAES), private universities and research institutes, and industrial research organizations.

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Technological Objective 1.

New and improved fundamental knowledge of the biology of weeds for development of safe, new principles and mechanisms of their control by biological, chemical, cultural, ecological, physical, and integrated methods that will avoid or minimize hazards to nontarget organisms and to other components of the environment.

Research Locations:

5502	Tucson, Arizona	3402	Columbia, Missouri
7406	Stuttgart, Arkansas	1305	New Brunswick, New Jersey
5102	Albany, California	1307	Ithaca, New York
5604	Denver, Colorado	7092	Raleigh, North Carolina
7702	Tifton, Georgia	3090	Fargo, North Dakota
3302	Lafayette, Indiana	7302	College Station, Texas
1103	Beltsville, Maryland	7307	Temple, Texas
1208	Frederick, Maryland	5702	Logan, Utah
7402	Stoneville, Mississippi	5802	Pullman, Washington

Selected Examples of Recent Progress:

The plant growth regulator ethylene stimulated the germination of several weed species - Beltsville, MD. Ethelene was evaluated for its effectiveness in stimulating the germination of seed of more than 50 weeds that infest croplands. The germination of 10 percent of these species was improved by ethelene. This discovery provides new approaches to improving the effectiveness and safety of selective chemical methods of control.

A bioassay was developed for determining the effectiveness of synthetic strigol as a witchweed seed germination stimulant - Raleigh, NC. The bioassay was effective at very low levels of strigol or the equivalent activity in solution of witchweed seed germination regulators from root exudate extracts of corn, cotton, peanuts, soybeans, sorghum, and wild

oat. The mechanism of the bioassay is based on the physiological role of strigol as a germination regulator, inhibiting conditioning when applied during an early stage of preconditioning and stimulating germination when applied at a later stage. The bioassay provides a new approach to evaluating the germination stimulation effectiveness of strigol and related chemicals for use in improving witchweed control technology.

Spikerush contains phytotoxic substances which inhibit the growth of aquatic weeds - Albany, CA. A bioassay was developed for evaluating the phytotoxic substances in spikerush, a low-growing competitive plant that shows promise for the control of aquatic weeds in large irrigation canals. Excellent progress was made in the isolation, separation, and identification of biologically active chemicals in spikerush. Several fatty acids such as myristic, palmitic, stearic, and oleic have been isolated and identified as well as ferulic and p-coumaric acids. Although some of these compounds show biological activity, none of them can be considered to be the phytotoxic principles in spikerush which inhibit the growth of aquatic weeds. Additional compounds have been isolated and are being identified. The allelopathic effects caused by spikerush in preventing the growth of aquatic weeds in irrigation systems afford a new approach to the control of aquatic weeds in irrigation water conveyance systems.

Some crop plants show allelopathic effects on the germination and growth of weeds - Frederick, MD. The allelopathic effects of root exudates from crop plants on the growth of several weeds were determined. These discoveries are providing new approaches to the selective control of weeds in crops. Exudates from sunflower roots inhibited the growth of pigweed but had no effect on seven other weed species. Root exudates from oat inhibited the growth of velvetleaf and stimulated the growth of giant foxtail. Thirteen varieties of sunflower were evaluated for their allelopathic effects in suppressing weed growth and weed populations. One variety reduced the total weed cover by 33 percent, as determined by a survey one year after the sunflower crop was harvested. Dried leaf and stem tissue leachates from the same sunflower variety significantly inhibited the growth of jimsonweed, quackgrass, common lambsquarters, and common morningglory. Sunflowers exerted the greatest influence on weed populations when the sunflower seedlings were four to five weeks old.

First weed growth model developed - Lafayette, IN. Setsim, a model of foxtail growth, has been verified, validated, and used to simulate foxtail growth over two growing seasons. Setsim has accurately predicted dry matter accumulation, plant height, leaf area, and leaf-stem-ratios. This weed model can serve as a framework for other weed models, determine the active stage of weed growth, predict whether a weed could become a problem under different climatic and edaphic conditions, and interface with crop models to predict yield and harvest losses. Such models have the potential to predict crop yields and harvest losses and could become an integral part of integrated weed management systems for improved weed control technology on farms.

Basic research helps explain the competitiveness of weeds with crops - Stoneville, MS. The photosynthetic rate per unit mesophyll volume or per unit leaf dry weight in velvetleaf is two to three times greater than in cotton. Therefore velvetleaf has a more efficient photosynthetic system in terms of the amount of CO_2 fixed per unit of dry matter allocated

to the leaves. Velvetleaf and redroot pigweed have higher relative growth rates, relative leaf area expansion rates, leaf area ratios, net assimilation rates, and leaf area partition coefficients than cotton regardless of the light intensity in which the plants were grown. Short-term chilling (equivalent to field conditions during "cold periods" early in the growing season) inhibited the growth of cotton more than the growth of two closely related weeds, velvetleaf and spurred anoda. The advantage of the weeds over the crop in dry weight and leaf area production is greater when both the weed and crop are subject to chilling than when neither is chilled. These findings help explain why velvetleaf and spurred anoda are stronger competitors with cotton during and following abnormally cool weather.

The exotic noxious weed, itchgrass, poses a threat to crops in the South and Southwest - Stoneville, MS. Itchgrass, one of the world's worst 18 weeds, is presently limited in the United States to infestations in Florida and Southern Louisiana where it is a serious problem in sugarcane. Throughout the tropical and subtropical areas of the world, itchgrass is a serious noxious weed in soybeans, corn, peanuts, sugarcane, and cotton. By growing this weed in 36 combinations of day and night temperatures in controlled environment greenhouses, it was found that best growth occurs at day temperatures above 26°C and night temperatures above 23°C. Controlled environment research of this type enables scientists to predict that itchgrass is likely to pose a serious threat in crop production throughout the South and Southwest where the growing season temperatures are favorable to its growth. Low summer night temperatures are expected to restrict its spread into the Cornbelt.

Corn hybrids show differential tolerance to herbicides - St. Paul, MN. The F_2 generations of 238 commercial corn hybrids were evaluated for their tolerance to diclofop. Several of the hybrids showed considerable tolerance to this herbicide. In the greenhouse, 240 hybrids were evaluated for their tolerance to trifluralin, a herbicide widely used for weed control in soybeans in the northern states. Corn hybrids tolerant to trifluralin are desired for use in rotations following soybeans treated with this herbicide. Small differences in tolerance were found among the hybrids but the levels of tolerance were not great enough to be of practical value in rotations following the use of trifluralin for weed control in soybeans.

Technological Objective 2.

New and improved weed control technology for use in field crops that will increase efficiency in food, feed, and fiber production, reduce losses in yield and quality, and reduce the cost of control.

Research Locations:

7406	Stuttgart, Arkansas	7412	Houma, Louisiana
5203	Shafter, California	3502	St. Paul, Minnesota
5602	Fort Collins, Colorado	7402	Stoneville, Mississippi
7702	Tifton, Georgia	3090	Fargo, North Dakota
3311 & 0703	Urbana, Illinois	5806	Prosser, Washington
3302	Lafayette, Indiana	5802	Pullman, Washington

Selected Examples of Recent Progress:

Integrated weed management systems provide excellent wild oat control - Fargo, ND. Herbicide-crop-fallow rotations have demonstrated that more than 95 percent of wild oats can be controlled. If effective wild oat control is obtained in any given year in the rotation, seed reserves in the soil can be reduced nearly 90 percent. Heavy infestations of wild oat can be reduced in two years with one year of fallow followed by crops treated with a preemergence and a postemergence herbicide for wild oat control. In field locations, diclofop gave 95 percent wild oat control and more than doubled wheat yields. However, even when 95 percent wild oat control was obtained, 68 kilograms per hectare of wild oat seed were still produced. Thus, eradication of wild oat is probably impractical. Emphasis in research is now being directed to the development of a plant growth regulator that will cause wild oats not controlled to remain on the stalks and be harvested with the crop rather than to be recycled in the soil. This approach will prevent replenishing the seed reserve in the soil profile.

Cropping-herbicide systems provide effective control of red rice in rice fields - Stuttgart, AR. A system of two years of soybeans treated with effective herbicides combined with cultivation reduced red rice sufficiently for profitable rice production in the third year. Effective interchangeable herbicide treatments are alachlor, trifluralin, profluralin, fluchloralin, metolachlor, and mixtures of these with metribuzin applied as preplant treatments gave effective control of red rice. A cropping system consisting of grain sorghum, soybeans, and rice was also effective in controlling red rice when the crops in the rotation were treated with herbicides normally used for controlling weeds in these crops. Red rice can also be reduced when rice is grown continuously if herbicides, cultural practices, and water management treatments are combined with preplant treatments of molinate followed by water seeding and combined with continuous flooding.

Plant pathogen controls northern jointvetch in rice - Stuttgart, AR. An endemic fungus, Colletotrichum gloeosporioidies f.sp. aeschynomene (CGA), used as a bioherbicide consistently gave more than 95 percent control of northern jointvetch in rice and soybean fields in a three-year study. This fungus is specific for northern jointvetch and does not injure rice, soybeans, or nontarget crops. It is safer to use CGA to control weeds in rice and soybeans growing near nontarget crops than the standard phenoxy herbicides. CGA has little or no toxicity to dogs, quail, mallard ducks, bluegill, guinea pigs, rabbits, and rats. The next objective is to obtain registration under the provisions of FIFRA for the use of the first bioherbicide for weed control in intensively cultivated crops.

Integrated weed management systems improve crop yields and net profits - Tifton, GA. Three years of integrated weed and pest management research involving intensive cropping sequences have caused yield differences which may be the result of interactions involving herbicides, nematicides, fungicides, and cultural practices. Weed populations have significantly decreased. Detailed economic analysis of selected systems over a three-year period indicate that the net profits may range from a loss of as much as $450 per acre, to a gain of more than $300 per acre--depending on the levels of pest management, crop production, and current crop prices.

Herbicide treatments developed for the control of new weeds in sugarcane fields and drainage ditches - Houma, LA. A new broadleaved weed, (Aster-lateriflorus) that cannot be controlled by 2,4-D has spread rapidly in sugarcane fields in Southern Louisiana. Recent research has resulted in the development of herbicide mixtures including asulam and either silvex or dicamba that effectively control this weed. Scouring rush horsetail, a weed that spreads primarily by rhizomes, is rapidly invading drainage ditches in sugarcane fields in Southern Louisiana. Soil applied treatments involving bromacil, tebuthiuron, or a recently discovered herbicide, have proven effective for the control of this weed. One of these treatments applied to new infestations will help to prevent further invasion of this weed into drainage ditches in sugarcane fields.

Crop-herbicide rotations for weed control increased crop yields and net profits - Urbana, IL. In a 13-year research program to evaluate the effectiveness of crop and herbicide rotations for weed control in crops, yields were increased 20 to 25 percent when herbicides were used to supplement cultivation as compared to cultivation without the use of herbicides. An economic analysis of the yield data for 13 years indicated that the use of herbicides increased net profits by 30 to 60 percent when compared to the use of cultivation for weed control without the use of herbicides. Weed seed levels in the soil were lowered by 90 percent when herbicides were rotated each year with cultivation as compared to cultivation without the use of herbicides. Weed seed levels increased 10 to 20 percent when herbicides were not used and cultivation was the only method of weed control. The herbicide treatments did not change the number or kinds of soil microorganisms nor cause any other harmful effects. The use of herbicides in crop rotations did not increase or decrease disease problems when compared with plots that did not receive herbicide treatments.

Sequential herbicide treatments for weed control in sugarbeets reduced weed losses and increased yields and net profits - Fort Collins, CO. Sequential herbicide treatments consisting of the use of ethofumesate plus diclofop as a preplanting treatment followed by a postemergence mixture of phenmedipham and desmedipham reduced the competitiveness of annual weeds to the extent that the yield of sugarbeet roots was 32 tons per hectare higher than the yields produced where only the standard herbicide and cultivation practices were used. When the degree of weed control, sugarbeet tolerance, root yields, and net return per acre were considered, this improved sequential treatment of herbicides returned a net profit of $736 per hectare above that of the standard treatment. Without the use of herbicides, broadleaved weed competition reduced yields 8 to 53 percent.

New cotton varieties are tolerant to herbicides used for weed control in cotton in the irrigated west - Shafter, CA. The results of a three-year study have shown that preplanting soil-incorporated treatments of trifluralin or directed postemergence treatment with diuron did not alter stand, yield, or fiber properties of four new varieties of cotton now widely grown in the irrigated west. The research demonstrated that the genetic diversity among these new cotton varieties does not require modification of long accepted chemical weed control practices that were developed for older cotton cultivars that are not currently grown in the irrigated west.

Crop rotations plus herbicides control yellow nutsedge - Shafter, CA. A three-year crop rotation that included alfalfa, silage corn, and cotton treated with recommended herbicides for weed control reduced nutsedge tuber populations in the soil by 95 percent in three years. Chemical fallowing with glyphosate during the summer following winter barley for two years preceding cotton and continuous cotton treated with MSMA reduced tuber populations 88 and 83 percent within three years. This research clearly demonstrated that the use of herbicides in other crops can reduce nutsedge populations in cotton soils by 95 percent.

New method discovered for the chemical control of weeds in small seeded legumes - Prosser, WA. EPTC applied directly in the row with alfalfa seed gave excellent control of annual grasses in bands 5 to 8 cms wide and alfalfa was not significantly injured. This novel method had not been tried previously because it was assumed that such concentrations of herbicides near the crop seed would be lethal. The new method opens many possibilities for efficient, economical, and safe weed control in alfalfa and other crops, especially where mechanically simple and inexpensive methods of weed control are needed.

Integrated weed management systems controlled weeds, reduced tillage and soil erosion losses, and increased wheat yields - Pullman, WA. Excellent weed control was obtained in the fallow year by combining fall applications of atrazine or metribuzin or early spring applications of amitrole, glyphosate, or paraquat with delayed reduced tillage. Yields from this integrated fallow weed management system were superior to zero-tillage-fallow. In intermediate rainfall zones, spring wheat or barley with zero tillage gave acceptable yields when the weeds were controlled by a combination of herbicide applications that gave control of broadleaved weeds and wild oats. These systems reduced tillage requirements and greatly reduced runoff and soil erosion losses.

Technological Objective 3.

New and improved weed control technology for use in horticultural crops that will increase production efficiency, reduce losses in yield and quality, and the cost of control.

Research Locations:

7702	Tifton, Georgia	1305	New Brunswick, New Jersey
1103	Beltsville, Maryland	7202	Weslaco, Texas
1208	Frederick, Maryland	5806	Prosser, Washington

Selected Examples of Recent Progress:

A new herbicide applicator developed for applying nonselective herbicides for selective control of weeds in crops - New Brunswick, New Jersey. A continuous belt herbicide applicator was developed to wipe herbicides on the top of weeds without bringing herbicides into contact with the crop. The new continuous belt sprayer wipes the herbicides on weeds that are taller than the cranberry vines thus permitting the use of a nonselective herbicide to control the weeds without injury to the crop. The herbicide glyphosate was applied using the continuous belt applicator to a cranberry

bog infested with a sedge. One year later, 100 percent control was obtained and the yield of cranberries was increased by 55 percent. The increase in yield was valued at $1,100 per acre more than the cranberries harvested from the untreated weed infested plots. This new herbicide application technique provides many new opportunities for using contact systemic herbicides on weeds without injury to crops. It not only reduces the likelihood of damage to the crop, but also reduces the chance of residues occurring in the crop and affords new approaches to developing improved weed management systems in sensitive crops.

New improved herbicides evaluated for weed control in horticultural crops - Beltsville, MD. Eleven new chemicals from nine different suppliers were evaluated for their effectiveness as preemergence treatments for weed control in 12 horticultural crops. Three of the new herbicides were effective for the control of grasses in broccoli, brussel sprouts, cabbage, swiss chard, upland cress, endive, collards, mustards, turnips, and lettuce. These new herbicides are expected to make significant contributions to the development of integrated weed management systems in horticultural crops.

Protectants prevent herbicide injury to horticultural crops - Tifton, GA. Charcoal was evaluated for its effectiveness in protecting tomatoes and watermelons against the phytotoxicity of a herbicide with marginal crop tolerance and one with no tolerance to both crops. Both herbicides gave excellent weed control and the charcoal protected the crops against phytotoxicity from both herbicides. Protectants of this type broaden the usefulness of currently registered herbicides and reduce the likelihood of crop injury and the occurrence of residues in crops. Such protectants also improve the usefulness of herbicides in integrated weed management systems.

Results from a 5-year study will aid in registering a herbicide for weed control in onions - Weslaco, TX. A five-year study has resulted in developing the herbicide bromoxynil for selective weed control in onions. The use of this herbicide eliminates fuel required to soil-incorporate many herbicides; conserves fuel by reducing tillage requirements; controls several weed species that are not controlled by currently registered herbicides; provides the consumer with wholesome, low-priced vegetables; and frees field laborers from tiresome work and ineffective hand weeding of vegetables. The results of this five-year study will be helpful in achieving the registration of bromoxynil. This herbicide will greatly improve integrated weed management systems for vegetable crops.

Weeds impair the yield and quality of mint oil, but herbicides had no effect - Prosser, WA. Lambsquarters, horseweed, and western goldenrod mixed with mint hay at percentages of 10 percent or greater significantly reduced the mint oil quality. Twenty percent of pigweed and prickley lettuce were required to reduce mint oil quality. Oil quality was not affected by barnyard grass. Paraquat plus terbacil, napropamide, and bentazon applied to field-grown mint did not affect the yield or quality of mint oil.

Soil applied herbicides for weed control in peas did not increase the disease incidence - Prosser, WA. In liquid culture and at rates of application comparable to those recommended for the control of weeds under field conditions, none of the nine dinitroaniline herbicides evaluated

affected the growth of Pythium or the sporulation of Fusarium solani sp. pisi and Fusarium oxysporum sp. pisi. Dinoseb applied as a preemergence treatment reduced the growth of Pythium mycellium and the sporulation of F. oxysporum sp. pisi. The results of these investigations indicate that the herbicides used for weed control in peas are not likely to increase disease incidence in this crop.

Herbicides evaluated for weed control in selected speciality crops - Frederick, MD. Paraquat was evaluated for controlling weeds as a directed spray in tomatoes and peppers grown with plastic mulch and paraquat. Glyphosate was evaluated for weed control in strawberries grown with plastic mulch. Both herbicides gave excellent control of weeds in both crops, increased yields, and improved quality. Herbicide residue data are being obtained on these uses and the results of these analyses along with efficacy data will be used to support the registration of both herbicides. This research is being coordinated with the interregional research project IR-4 in an effort to increase the number of registered herbicides for controlling weeds in speciality crops.

Technological Objective 4.

New and improved weed control technology for use in forage crops, pastures, rangelands, and turf that will increase efficiency of food and feed production, improve aesthetic values, reduce losses in yield and quality, and reduce the cost of control.

Research Locations:

5514	Flagstaff, Arizona	5208	Reno, Nevada
5502	Tucson, Arizona	1307	Ithaca, New York
7702	Tifton, Georgia	5809	Corvallis, Oregon
1103	Beltsville, Maryland	7302	College Station, Texas
3402	Columbia, Missouri	7307	Temple, Texas
3416	Lincoln, Nebraska	5702	Logan, Utah

Selected Examples of Recent Progress:

Herbicides control weeds and aid in turf renovation - Beltsville, MD. Glyphosate applied two to three times, with four to six weeks between applications, was effective in killing Burmuda grass and other undesirable weeds and turf grasses. When the herbicide application was followed by appropriate seedbed preparation treatments, excellent stands of improved turf grasses were effectively established. When the herbicide was used alone without appropriate seedbed treatments, stands were not established as effectively. Poor turf grass stands resulted in turf renovated without the use of glyphosate. A predominantly red fescue turf, treated for three years for crabgrass control with bensulide, butralin, profluralin, and DCPA was shifted ecologically to Kentucky bluegrass. These experiments show that herbicides can be used to cause ecological shifts to a more desirable turf grass mixture, rather than killing the entire stand and renovating by reseeding.

Establishment of pastures and forage crops by the use of herbicides, minimum tillage and improved forage mixtures - Ithaca, NY. The components of

a system to establish forage crops with the aid of herbicides and without plowing the soil has been achieved. In field experiments, the combination of effective, safe herbicides and newly developed equipment makes it possible to plant improved forage legumes and grasses directly into sod, corn, and small grain stubble. These components plus forage mixtures with varying competitiveness with weeds will be pilot tested in an integrated weed management system on many soil types and ecological sites in the northeast during the next five years. The results of the pilot test are expected to be useful in making major improvements in the establishment and culture of forage crops and pastures in the northeast.

An insect weevil successfully controls musk thistle in Nebraska - Lincoln, NE. An insect weevil (Rhinocyllus conicus) has been definitely established in Valley, Pawnee, Saunders, and Boyd Counties in Nebraska. In Valley County, by the sixth summer after the initial release, the weevils have spread to an area about five miles in diameter. Sampling revealed many thistle heads with 20 or more larvae and no viable seed. The colony started a year later in Pawnee County has spread to an area of about 1,000 acres. Detailed studies are in progress at the Saunders County site to monitor both the numbers of insects and thistle.

Deep plowing and herbicides control wild garlic - Columbia, MO. Basic research to characterize the carbohydrate reserves of wild garlic shows that they decline gradually throughout the fall and reached a low point in March. The results of this research suggested that the carbohydrate reserves may be sufficiently low after October 1 so that emergence of the plant would be inhibited by herbicide treatments and deep plowing. Several herbicides were evaluated for use in controlling wild garlic before tillage in the fall for wheat and in the spring before tillage for corn and soybeans. Several herbicides were effective in controlling wild garlic at both stages of growth. Wild garlic has consistently failed to emerge in these experiments if buried six to eight inches deep after October in the fall or early in the spring. Periodic inspection of the buried plants showed that they became etiolated and were unable to emerge from the soil. Thus, plowing six to eight inches deep in October followed by planting of wheat will make it possible to keep wild garlic infestations low in this important crop and avoid the excessive use of herbicides for wild garlic control in wheat.

New herbicide controls brush and weeds and aids in the establishment of improved forage grasses - College Station, TX. Tebuthiuron, a new soil active herbicide, was found to be one of the most effective weed and brush control chemicals investigated. It is highly effective for the control of whitebrush, post oak, blackjack oak, white ash, winged elm, and moderately effective on yaupon, mockernut hickory, tree huckleberry, huisache, honey mesquite, and Macartney rose. The new herbicide was also effective in controlling smut grass and a broad spectrum of other herbaceous pasture weeds. Pellet formulations applied broadcast or in bands were usually about equally effective. Subsurface sprays were more effective in controlling some woody species than surface applied sprays. Preplant applications of tebuthiuron and glyphosate increased the production of klein grass seeded 120 days after tebuthiuron treatment and 60 days after glyphosate treatment. Burmuda grass stands were significantly increased when tebuthiuron was applied 120 days prior to sprigging. Crude protein

levels of klein grass grown in plots treated with tebuthiuron were significantly greater than levels found in grass in the untreated control plots.

Ethofumesate, given exemption by EPA under Section 18 of FIFRA, for winter annual grass weed control in Italian rye grass seed fields - Corvallis, OR. Research data on the efficacy and safety of ethofumesate submitted to EPA to obtain an exemption for the use of this unregistered herbicide for weed control in Italian rye grass seed fields was provided by this research project. This is the only herbicide available that will selectively control winter annual grass weeds in Italian rye grass seed fields. The exemption from the registration requirement provided seed growers with a chemical means of controlling weeds in the approximately 45,000 acres of Italian rye grass seed fields that could not be burned in 1977 because of environmental constraints.

Herbicides developed for the control of junipers and oaks in Arizona - Flagstaff, AZ. Currently there are no herbicides registered for use in Arizona which are effective in controlling junipers and oaks. Research conducted at Flagstaff has provided data that will be used to obtain registrations for picloram and tebuthiuron for controlling junipers and oaks. This will permit using these herbicides along with integrated weed and brush management systems to control these difficult to control, undesirable woody plants. The use of these herbicides will help restore lost forage production for wildlife and livestock, protect soils from excessive erosion, increase water yields from treated areas, increase forage yields and livestock production, and ranchers income.

Surfactants improve the effectiveness of low concentrations of 2,4,5-T for control of catclaw in Arizona - Tucson, AZ. Basic research on leaf topography, epicuticular wax ultrastructure, and resultant herbicide deposition patterns visualized by the scanning electron microscope emphasized the importance of using appropriate droplet sizes and surfactants to improve the effectiveness of herbicides. At high 2,4,5-T concentrations (8500 ppmw),the addition of a surfactant did not increase the herbicidal activity and effectiveness of 2,4,5-T. However at progressively lower 2,4,5-T concentrations (800 ppmw), the surfactant greatly increased the phytotoxicity and effectiveness of 2,4,5-T for controlling catclaw. At the lowest concentration of 2,4,5-T, 0.1 percent surfactant reduced catclaw growth by six percent, while 2.1 percent surfactant reduced it by 52 percent. These results have important implications in attaining optimum herbicidal activity from low herbicide concentrations, thus minimizing undesirable 2,4,5-T residues and potential environmental contamination.

Ecology and control of alfombrilla, a weed poisonous to livestock - Tucson, AZ. The kinds of environment in which alfombrilla will grow and measures for its control were developed in the event this weed enters the United States from Mexico. Pollination, temperature, and day length requirement for optimum growth were determined. Seeds of the poisonous alfombrilla were found to have a germination rate of less than 5 percent immediately after harvest, but after 20 months germinated at the rate of approximately 80 percent. This after-ripening period is an important factor in developing strategies for the eradication of this plant if it enters the United States. Picloram was effective for controlling all alfombrilla plants in experimental plots located in Northern and Central Chihuahua, Mexico. Picloram gave better control of alfombrilla than tebuthiuron, dicamba, silvex, or

triclopyr, and less injury to grasses than tebuthiuron. If alfombrilla is found in the United States, picloram will be the herbicide of choice if eradication is the objective.

Poisonous constituents idendentified in Alfrombrilla, a weed poisonous to livestock in Mexico - Logan, UT. An analysis of saponin content in alfrombrilla in relationship to plant toxicity was completed. Plant toxicity to one-week old chicks increased or decreased in inverse proportion to the saponin content of the plant. Saponin content was high from May to October and greatest in September when the plants were producing seed. The results of this research will be useful to Mexican ranchers and to United States ranchers if alfrombrilla enters this country, since it establishes the periods during the year when the plant is most poisonous and grazing in infested areas should be avoided. From the results of this research ranchers can use an excellent integrated weed management system involving the selective use of picloram which is effective in controlling alfrombrilla and grazing management practices designed to avoid infested areas.

Selective chemical control of barbey larkspur, a poisonous range weed, dramatically reduces deaths of cattle - Logan, UT. The use of selective herbicides to control barbey larkspur dramatically reduced the deaths of cattle on rangeland in Utah. Ranchers that grazed cattle on larkspur infested range realized a higher rate of return for their investment in the selective chemical control of larkspur than for any other investment in rangelands. In one pilot research program in a larkspur infested subalpine grazing area, the cost of selective chemical control of larkspur in the infested area was about $2,000. Based on the actual records of animals poisoned in the area in the past, 60 to 90 animals worth $15,000 to $22,000 would have been poisoned by this weed. This illustrates the high net return that can be expected from investments in selective chemical control of poisonous plants. The results of this research can be applied to most of the poisonous species in the Western States where these plants cause millions of dollars in livestock losses and reduced grazing annually.

Development of integrated weed and brush management systems and seeding technologies improved the productivity of Western rangelands - Reno, NV. Effective, efficient, and safe weed control and seeding technologies have been developed and perfected for use on sagebrush infested rangeland ecosystems in the Western United States. These technologies include selective chemical and mechanical methods for control of dominant shrub species, selective chemical control of downy brome and other herbaceous weeds, seeding methods for establishment of improved perennial grasses and other forage and browse species, and culminating in development of weed control-revegetation systems for conversion of degraded, low-producing plant communities to stable, high-producing rangeland ecosystems. These technologies are widely applicable for greatly improving the productivity of millions of acres of degraded low-producing rangelands in the Western States.

Technological Objective 5.

> New and improved weed control technology for controlling, managing, or using weed populations to improve water quality, fish and wildlife habitats, and recreational areas in aquatic and noncropland sites.

Research Locations:

5206	Davis, California	7402	Stoneville, Mississippi
5604	Denver, Colorado	5806	Prosser, Washington
7615	Fort Lauderdale, Florida		

Selected Examples of Recent Progress:

A new insect introduced as a biocontrol agent for waterhyacinth - Fort Lauderdale, FL. Four years of intensive research by SEA scientists in Argentina and Florida have resulted in the introduction of an Argentine moth (Sameodes albiguttalis) and its evaluation for effectiveness and safety in controlling waterhyacinth. The Argentine moths fly farther than two weevils previously introduced, and the moths will also produce larger populations in shorter periods because of a shorter (34 day) life cycle. It is expected that the moths will spread more rapidly and will have a greater influence in controlling waterhyacinth than the Neochetina weevils alone. SEA scientists and cooperators are monitoring the dispersal patterns of the moths and other insects to develop technology for future releases and biocontrol of waterhyacinth. These moths, along with other insects, water management, and the use of selective herbicides are providing improved technology for use in integrated aquatic weed management systems.

New, highly selective and environmentally compatible herbicides were evaluated for aquatic weed control - Fort Lauderdale, FL. Twenth-eight new chemicals were evaluated in the laboratory, greenhouse, or in outside aquaria for their effectiveness in controlling aquatic weeds such as waterhyacinth, alligatorweed, chara, paragrass, torpedograss, and hydrilla. Advanced field research was conducted to obtain efficacy and residue data that will be used to support the registration of Velpar and fenac for control of hydrilla. These new herbicides will be used to supplement the use of insects, plant pathogens, water management, and other control components to develop effective, safe, and environmentally compatible integrated aquatic weed management systems.

Plant hormone produces dwarf-like aquatic weeds - Denver, CO. The synthetic plant growth regulator, abscisic acid (ABA), at very low concentrations inhibited the germination of vegetative winter buds of American pondweed and sago pondweed. A new physiological function for ABA not previously known was discovered. At low concentrations, ABA produced dwarf-like plants of American pondweed, a principal noxious aquatic weed in many Western irrigation systems. In addition to the dwarfing effect on pondweeds, ABA induced formation of floating type foliage which is expected to increase the susceptibility of pondweeds to herbicides and increase the effectiveness and safety of herbicides for control.

Cooperative research to develop efficacy and safety data to support the registration of aquatic herbicides - Denver, CO. SEA scientists are cooperating with scientists of the Bureau of Reclamation and Fish and Wildlife Service, U.S. Department of the Interior, and industrial research organizations in a program to obtain efficacy and safety data to support the registration of herbicides for use on Federally owned or managed water conveyance systems. In 1978 continuing progress was made in a multiagency-industrial cooperative program to obtain water residues, efficacy data, crop residue data, and other information on aquatic organisms in

order to support petitions for registrations. The following herbicides are under cooperative investigation: (1) dicamba, for use in controlling ditchbank weeds; (2) simazine, for the control of ditchbank weeds; (3) MCPA and MCPP for the control of aquatic and ditchbank weeds; and (4) acrolein, to determine its effectiveness and safety for use in areas containing desirable fisheries. Progress has been made in obtaining the data needed to support registrations. The use of these selective herbicides is critically important to the development of efficient and safe integrated aquatic and terrestrial weed management systems for use on Federally owned or managed lands and water resources.

Thirty-four new chemicals evaluated for their effectiveness in controlling aquatic weeds in irrigation systems - Davis, CA. Thirty-four new chemicals were evaluated for their herbicidal effectiveness in controlling representative species of aquatic weeds. Seven of the new chemicals were considered to have significant selective herbicidal properties that justified additional evaluation research. However, three of these, buthidazole, Velpar, and terbutryn, showed exceptional herbicidal selectivity and specificity and were considered significant candidates for field evaluation and further developmental research. The development of selective, biodegradable, and environmentally compatible selective aquatic herbicides is critically important to developing a diversity of component control methods that can be used in the development of integrated aquatic weed management systems.

Biological control of aquatic weeds with spikerush, a plant competitor - Davis, CA. Intensive research was continued to develop a better understanding of the life history of spikerush and to determine its practical competitiveness for control of aquatic weeds, especially in large irrigation systems and reservoirs. Emphasis was on developing a better understanding of factors such as temperature, light, soil, water quality, and other site requirements that support the submersed growth of spikerush on bottom soils. Optimum conditions for seed production, propagation, storage of propagules, establishment of spikerush, and other growth requirements are being determined. A fullscale pilot study is being initiated to speed-up the development of spikerush for practical control of aquatic weeds in large irrigation systems and large water reservoirs.

Forage plants show promise as replacement vegetation for ditchbank weeds - Prosser, WA. Sixty-two plant introductions of creeping red fescue from 14 countries and four varieties of the species were evaluated for their effectiveness in replacing weeds that are controlled on irrigation ditchbanks. Most of these species grew well at Prosser but several plant introductions from Alaska and Canada were moderately susceptible to powdery mildew and a rust. The stature, rate of spread by rhizomes, leaf width, date of heading and anthesis, winter hardiness, and winter dormancy varied widely among the selections. The tolerance of the introduced species also varied widely to treatments of glyphosate, a herbicide used widely for the control of irrigation ditchbank weeds. Some of the species appeared sufficiently tolerant to glyphosate to permit the selective use of this herbicide for maintaining weed control in plantings of the introduced species. This research is part of a continuing effort to develop insects, plant pathogens, selective herbicides, competitive plants, and replacement vegetation possessing significant tolerance to permit the use of selective herbicides for weed control maintenance in integrated aquatic and ditchbank weed management systems.

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National Research Program 20290

AGRICULTURAL CHEMICALS TECHNOLOGY FOR
CROPS PROTECTION AND MODIFICATION

This basic, multidisciplinary, national research program deals with the development of new knowledge, new concepts, and new principles on the relationship of chemical structure to biological activity; including the nature, behavior, and fate of chemicals in soils; their mechanisms of entry, movement, activity, selectivity, metabolism, and fate in plants; their performance efficiency; and safety to crops, soils, and nontarget organisms in the environment. This research is essential to the efficient and safe use of pesticides and plant growth modifiers in the development of high-yielding food, feed, and fiber agroecosystems that will maintain the nation's food supply and improve the quality of the environment. This program supports the missions and goals of SEA and the Department. It is organized into 33 projects at 14 locations and is conducted by 21 SEA scientists in cooperation with several Federal agencies, State agricultural experiment stations (SAES), private universities and research institutes and industrial research organizations.

NPS Contact: W. C. Shaw PACS Contact: L. L. Jansen

Technological Objective 1.

New concepts and knowledge for improving the primary evaluation, and structure-activity assessments for enhanced development of improved herbicides, fungicides, nematicides, insecticides, and growth regulators that are compatible with a quality environment.

Research Locations:

5102	Albany, California	1208	Frederick, Maryland
1110	Beltsville, Maryland	7092	Raleigh, North Carolina
1103	Beltsville, Maryland	3602	Fargo, North Dakota

Selected Examples of Recent Progress:

New chemicals show promise as nematicides - Beltsville, MD. In primary nematicide evaluation research, high nematicidal activity was detected in 29 new straight and branched chain amines and in additional new compounds where amide and amine moieties were replaced by other substituent groups. The results of this chemical structure-nematicidal activity research has established new principles that will provide helpful guidelines for the synthesis of new, highly specific nematicides with greater effectiveness and safety to nontarget organisms.

New safer, easier to use nematicide formulations developed - Beltsville, MD. SEA scientists have devised and evaluated under greenhouse conditions a new granular formulation for nematicides with controlled release characteristics. DBCP and diazinon are retained in the dry granules and are emitted over an extended period when the granules are worked into the soil and are subjected to soil moisture. In dry soils, granules dry out and retain the

remaining nematicide. This capability, which will be field evaluated, promises increased efficacy from reduced nematicide concentrations and will provide the grower with new opportunities for applying reduced dosages of nematicides without specialized equipment under safer handling and application conditions.

New chemicals show promise as selective herbicides and controlled release formulations improve the effectiveness and safety of currently used herbicides - Beltsville, MD. Twenty-three new chemicals were evaluated for their effectiveness in controlling a broad spectrum of weed grasses and broadleaved weeds in more than 30 crops. Nine of the new chemicals gave excellent control of both broadleaved weeds and grasses. One or more of the nine promising new herbicides were tolerated by buckwheat, corn, cotton, flax, safflower, soybeans, peanuts, and alfalfa. Starch xanthate controlled release formulations of trifluralin more effectively controlled the release of the active ingredient of this herbicide than did commercial and microencapsulated formulations. Field studies with this controlled release formulation of trifluralin confirmed the controlled release rates initially established under greenhouse conditions.

Basic research on the mechanism of action of herbicides leads to discoveries about the response of crops to heat and cold injury - Beltsville, MD. SEA scientists discovered that several structurally related chemicals in the pyridazinone group inhibited the formation of linolenic acid in plants. Plants with large amounts of linolenic acid were resistant to low temperature injury while plants with small amounts of linolenic acid were tolerant to high temperatures. Thus by chemically reducing levels of linolenic acid, certain weeds can be killed by stripping them of their natural resistance to chilling injury. The linolenic:linoleic acid balance in plant cell membranes is a key to the tolerance of plants to high temperatures or cold injury. Analysis of linolenic acid in certain crops will provide plant breeders with a rapid screening procedure for estimating cold resistance or, conversely, heat tolerance in crop plants. By chemically regulating linolenic acid in certain plants, it may be possible for them to tolerate adverse climatic conditions with less loss of yields. Screening plants for linolenic acid may facilitate plant breeding programs to develop crops with greater heat or cold tolerance.

New controlled release herbicide formulations improve efficacy and safety of chemical weed control practices - Lafayette, IN and Peoria, IL. New biodegradable, starch-encapsulated controlled release formulations of herbicides have demonstrated that the residual weed control effectiveness, safety to crops, and overall performance of several herbicides have been significantly improved. Cooperative research between chemists at Peoria, IL, and weed research scientists at Lafayette, IN, and several other locations, have shown that a new controlled release formulation of EPTC gave approximately 100 days of weed control as compared to approximately 30 days for the conventional emulsifiable concentrate. The results of these investigations and cooperative research involving more than 30 other SEA scientists indicate that further improvements can be made in the efficacy and safety of herbicides through the development of controlled release formulations.

Development of new and improved methods for detection and evaluation of plant growth regulators - Frederick, MD. A new technique was developed for the injection of measured amounts of plant growth regulating chemicals into woody plants. The new technique involves the use of a miniature injection device consisting of a pair of vise-grip pliers coupled with a detachable plastic wrench. This rapid, inexpensive, simple, and accurate application device improved our scientific capability to determine the chemical structure-biological growth regulating properties of new chemicals. Experiments on a wide range of fruit and shade trees have shown that the technique is suitable for use throughout the annual growth cycle with no hazard from the release of the chemicals to nontarget plants or into the environment. The new technique will greatly enhance our success in detecting, discovering, and developing plant growth regulating chemicals.

New herbicide-polymer controlled release systems improve the efficacy and safety of herbicides - Stoneville, MS. Several herbicide-polymer controlled release formulations have been synthesized and evaluated for controlled release properties, performance efficiency, and safety. Two of the new herbicide-polymer controlled release systems containing metribuzin molecules chemically bonded to the polymer matrix have exhibited release of the herbicide at a controlled rate in both water and soil systems. The increased effectiveness of this controlled release formulation of metribuzin in controlling weeds is encouraging. The preliminary results of these experiments clearly indicate that further advances in controlled release formulation technology will enhance the effectiveness and safety of herbicides for weed control in crops, reduce their effects on nontarget organisms, and will reduce their potential environmental impacts.

New wood preservative developed - Albany, CA. Excellent progress was made in isolating and structurally identifying biologically active compounds from plants that are resistant to insect or microbial attack or toxic to other organisms, and to determine whether these natural products can serve as models for the development of new, less environmentally hazardous pest control agents. SEA scientists, in cooperation with scientists of the Naval Research Laboratory, have shown that a simple phenol (2-benzyl-4,6-= di.tert.butyl phenol) which was easy to synthesize, preserves wood from attack by marine borers and other organisms in tropical waters. Some compounds currently used for this purpose include pentachlorophenol and creosote. However, both of these chemicals are subject to contamination by highly toxic dioxins. The new phenol wood preservative does not contain dioxin as a contaminant and appears to be more efficient than pentachlorophenol or creosote as a protectant against marine borers.

New repellents developed for the control of the confused flour beetle - Albany, CA. SEA scientists in Georgia and California have found that simple benzyl-mono alkyl phenols are highly effective repellents for control of the confused flour beetle, a major pest of stored cereal grains. These repellents are long lasting and more effective than the standard repellents that are in current use. These new repellents will be more useful for the preservation of cereal grains where direct contact with the insecticide is undesirable.

Technological Objective 2.

New and improved knowledge of the nature, behavior, and fate of agricultural chemicals in soils that influence the performance of pesticides and growth modifying chemicals and their safety to crops, soils, and nontarget organisms in the environment.

Research locations:

1103 Beltsville, Maryland
7402 Stoneville, Mississippi
7403 Stoneville, Mississippi

Selected Examples of Recent Progress:

Microagroecosystem developed for determining the behavior and fate of minute amounts of chemicals in the total environment - Beltsville, MD. The chemical 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), is a toxic contaminant that may be found at levels below 0.1 ppm in some formulations of herbicides derived from 2,4,5-trichlorophenol. By using very high specific-activity tritium labeled TCDD, scientists were able to measure TCDD in environmental samples of soil, plants, water, and air at levels of 10^{-12} to 10^{-16} g/g of soil, plants, and water, or g/m^3 of air. The microagroecosystem successufully contained the radioactive tritium and the highly toxic TCDD and demonstrated the utility of the system in following and evaluating the significance of minute amounts of a chemical in the total environment.

N-Nitrosamine contaminant in herbicides degrades rapidly in soils - Beltsville, MD. Soil metabolism studies with ^{14}C-labeled N-nitrosodipropylamine, a contaminant in some herbicide formulations, indicate that it has a half-life in soil of approximately 10 to 14 days. $^{14}CO_2$ production rates with three different labeled materials indicated that no stable intermediates accumulate between the initial metabolic step and final conversion to CO_2. This research indicates that nitrosamine would not be a persistent residue in soils.

Synthetic pyrethroid insecticides degrade rapidly in soils - Beltsville, MD. Synthetic pyrethroids are a new class of insecticidal chemicals that show promise as potential replacements for some of the chlorinated hydrocarbon insecticides whose uses have recently been restricted. Soil metabolism research with three ^{14}C-labeled forms of permethrin and cypermethrin indicates that these insecticides are rapidly and extensively degraded in soils. The major degradative route in all soils was hydrolysis of the ester linkage. Subsequent degradation of the hydrolysis products was examined. They degraded rapidly in aerobic soils but tended to accumulate in flooded soils. A minor degradative route was also identified.

Sewage sludge and feedlot wastes (manure) alter the degradation of pesticides in soils - Beltsville, MD. The degradation of fourteen ^{14}C-pesticides was determined in untreated soils as compared to soils amended by the addition of dairy manure and sewage sludge. Both organic amendments increased

$^{14}CO_2$ evolution with all pesticides which indicates that the pesticides examined had no adverse effects on soil microbial respiration. Increased rates of pesticide degradation were observed in sludge and/or manure amended soils for a number of structurally unrelated pesticides. However, ^{14}C-product distribution varied with soil amendments. The degradation of pesticides initially degraded by dealkylation reactions was inhibited by sewage sludge but enhanced by manure. These results indicate that pesticide degradation and persistence may be altered by the application of sewage sludge or feedlot wastes to agricultural soils.

Two aquatic model ecosystems developed for studying the behavior and fate of pesticides in standing and moving water habitats - Beltsville, MD. A recirculating static model ecosystem which simulates a standing water habitat and a flowing model ecosystem which simulates a moving water habitat were developed. In the static system the pesticide is introduced, absorped to soil at the beginning of the experiment only, and is thus subject to all degradation processes throughout the experimental period. The flowing system receives a fresh supply of the pesticide continuously so the effect of the chemical on the organism is maximized. The results indicate that the static system is the more useful for studying the effect of the environment on a chemical, whereas the flowing system is primarily useful for studying the effects of the chemical on one or more aquatic organisms. Also, the static system is less expensive and far simpler to prepare and operate than the flowing water system.

Behavior, fate, and toxicity of toxaphene to aquatic organisms in water - Beltsville, MD. Algae, snails, daphnia, and fish were exposed to two concentrations of unfractionated toxaphene and three fractions of toxaphene for 1 to 32 days in aquatic model ecosystems. The fractions differed significantly in polarity and acute toxicity to fish. Only slight differences were observed between the three fractions and unfractionated toxaphene in total amounts accumulated by the four organisms. Chemical analyses of fish and snail extracts indicated that all of the compounds were significantly metabolized by snails but that little metabolism of the compounds occurred in fish.

Soil moisture greatly reduces the persistence of dinitroanaline herbicides in soils - Stoneville, MS. The persistence of six dinitroanaline herbicides was shown to be dramatically decreased by flooding the soil. This effect could be observed when the duration of flooding was only 3 to 6 days. Since volatility was decreased under flooded conditions, this form of loss was not responsible for the rapid dissipation of these herbicides under flooded conditions. Half-lives of these herbicides ranged from 31 to 99 days under more moist soil conditions, and from 8 to 37 days when the soil was flooded.

Seasonal losses of herbicides in runoff water from agricultural watersheds are minor- Stoneville, MS. Seasonal losses of MSMA, trifluralin, and metribuzin averaged 2.0 percent, 0.1 percent, and 1.0 percent, respectively. The results of this research indicate that when good farming practices are followed, proper formulations of herbicides are used at the right time, and at recommended amounts, the losses of such chemicals through runoff from agricultural watersheds can be reduced to levels that are insignificant. The use of controlled release formulations of herbicides, subsurface soil

application techniques, soil incorporation methods and cropping systems will aid in further reducing the small amounts of these herbicides that can be measured in runoff waters from agricultural watersheds.

Technological Objective 3.

New and improved knowledge on the mechanisms of entry, movement, activity, selectivity, metabolism, and fate of applied pesticides and growth regulators in relation to their effective action in plants and their safety to subsequent crops and nontarget organisms.

Research Locations:

8003	Beltsville, Maryland	1109	Beltsville, Maryland
8001	Beltsville, Maryland	7802	Raleigh, North Carolina
1103	Beltsville, Maryland	3602	Fargo, North Dakota

Selected Examples of Recent Progress:

Basic weed research provides new principles of crop production and protection - Beltsville, MD. Basic research conducted to discover how herbicides kill plants resulted in the development of new chemicals which decrease high temperature damage to crops and reduce cold hardiness of plants. Herbicides of the pyridazinone class of chemicals kill plants by inhibiting photosynthesis. However, SEA scientists discovered that some of them also change the ratio of polyunsaturated fatty acids in plants. By structural modification of the herbicide it was possible to eliminate the conventional herbicidal properties and retain the desirable effectiveness in changing the polyunsaturates. The resulting chemicals were used to explain the basis of resistance or susceptibility to cold temperatures, a major contribution to plant science. The practical benefits of this research are the development of less hazardous herbicides which kill winter weeds by removing the protective mechanisms against freezing - weeds die by freezing; crop protection and potentially higher yields under high summer temperatures and drought conditions; information to discourage the use of herbicides which cause cotton damage and reduced stands by sensitivity of cotton to chilling injuries thereby requiring replanting; reducing the content of unsaturated fatty acids in soybean seed to reduce rancidity of soybean oil, quality control of sunflower seed oil to protect its marketability and type of use, and the possibility that the principle can be extended to insects to prevent overwintering of harmful pests as a new approach for integrated insect management.

Brassins, a new plant growth regulator complex, stimulates the growth and development of crop plants - Beltsville, MD. Various methods of applying purified brassin complex to stimulate growth and development of crop plants indicated that aqueous solutions stimulate growth of plants when they are in the seedling stage. Subsequent field research was successful in increasing crop yields. The biological activity of the brassin complex is dependent upon the presence of indole-3-acidic acid (IAA). The brassin complex has the novel characteristic to enhance IAA-induced growth. However, the biological activity of brassin in increasing plant growth exceeds that induced by IAA alone.

Probable mechanisms of selectivity of new wild oat herbicide revealed - Fargo, ND. Grass species such as wheat and wild oat are very similar. Consequently, selective control of wild oat in wheat and other grains is very difficult. A biochemical basis for the susceptibility of wild oat and tolerance of wheat to the new herbicide, diclofop-methyl, has been proposed. Ring-hydroxylation of diclofop may be the key metabolic reaction that determines diclofop-methyl selectivity. This knowledge can be utilized in the development of new chemicals or chemical combinations (synergists and antagonists) to increase the efficacy of diclofop-methyl.

Behavior and fate of pesticide additives determined in plants - Fargo, ND. Surfactants and other additives are used extensively in pesticide formulations. Unfortunately, basic information on their actions in plants is limited. Recent studies have provided the first definitive information on the absorption, movement and metabolism of a major class of nonionic surfactant additives in plants. This information should result in improved pesticide performance and safety through a better basic understanding of the behavior and fate of pesticide additives in plants.

Plant cell cultures developed as model systems for detecting, discovering, and evaluating the structure-biological activity relationships of pesticides and plant growth regulators - Fargo, ND. Comparative pesticide metabolism research with intact plants and plant cell cultures have established that the cell cultures often yield the same results in less time and at reduced cost. The benefits from the use of plant cell cultures in the future are expected to be substantial, particularly in the areas of rapid chemical structure-biological activity determinations, and in determining pesticide and plant growth regulator behavior and effects in plants at the cellular level. The use of plant cell cultures is expected to increase our scientific capabilities for detecting, discovering, evaluating, and developing pesticides and plant growth regulators.

Method developed for the analysis of "terminal" herbicide residues in plants - Fargo, ND. A pyrolytic method for the determination of "bound" chloroaniline herbicide residues in plants has been developed. This method may also be useful for the analysis of "bound" aniline residues in soils. Plants and soils often accumulate significant quantities of pesticide degradation products as "terminal" residues. In most cases, the nature and extent of these residues is unknown and methods for their analysis are limited. Since aniline-based herbicides are used extensively for crop protection, basic information on the extent of "bound" plant and soil residues is needed for an accurate and complete assessment of their environmental impact.

Technological Objective 4.

Develop new information on natural bioconstituents and related synthetic compounds that control physiological and biochemical processes for the development of chemicals to modify plant structure and processes.

Research Locations:

7702	Tifton, Georgia	7102	New Orleans, Louisiana
3102	Peoria, Illinois	1402	Philadelphia, Pennsylvania
1109	Beltsville, Maryland		

Selected Examples of Recent Progress:

A new plant growth regulating compound has been isolated from the seeds of the plum yew - Beltsville, MD. Seeds of the plum yew (Cephalotaxus harringtonia) were obtained from the worldwide collection of higher plants developed through the cooperative efforts of SEA scientists and scientists of the National Cancer Institute in their search for new anti-tumor compounds. The active plant growth regulator, harringtonolide, has an extremely complex structure consisting of six rings, including tropone and related moieties. The new chemical is a plant growth inhibitor and its partial spectrum of activity on plants has been determined.

Progress in isolating, identifying, and characterizing the structure and growth regulating properties of brassins - Beltsville, MD; Philadelphia, PA; and Peoria, IL. Brassins, a new plant growth regulating complex, have been isolated from rape pollen. A pilot plant concentrate representing 190 pounds of rape pollen was developed for studies on the isolation, characterization, identification, and for evaluating the growth regulating properties of brassins. Fractionation of rape pollen by a series of laboratory techniques ending with reverse phase, high-performance liquid chromatography afforded about one mg of pure brassin. Interpretation of electron-impact, chemical-ionization, and field-desorption mass spectrometry along with proton magnetic resonance and infared spectrometry indicated that brassin is a polyhydroxyketosteroid having a molecular weight of 480. These cooperative studies by SEA scientists at BARC, ERRC, and NRRC resulted in the further purification of brassin and yielded the first crystaline material that may contain the active principle(s). Research will be continued to determine the structure of brassins and to synthesize them for wider scale evaluation as plant growth regulators.

A new, potent inhibitor of plant growth isolated from a fungus - Tifton, GA. Hydroxyterphenyllin is a newly discovered metabolic from the fungus Aspergillus candidus, an organism that is often found contaminating flour. The new chemical is a potent inhibitor of plant growth. The parent compound isolated by Japanese scientists (terphenyllin) is not very active as a plant growth inhibitor. However, the new metabolite, hydroxyterphenyllin, is about 100 times more active. Terphenyllin is active against uterine cancer cells. However, since hydroxyterphenyllin discovered by SEA scientists is 100 times more active in plant bioassays, a sample has been made available to scientists of the National Institutes of Health for evaluation in leukemia and melanoma assays.

Technological Objective 5.

Improved automated search, storage, and retrieval systems for relating chemical structure and biological activity of pesticides and growth regulators, including their nature, behavior, and fate in all aspects of the environment.

Research Locations:

1208 Frederick, Maryland

Selected Examples of Recent Progress:

Improved information management systems for chemical and biological response data on herbicides and plant growth regulators developed - Frederick, MD. The Frederick data base with chemical and biological evaluation information on 31,000 herbicidal and growth regulator chemicals has been converted to a form compatible with the SEA computerized data bank on agricultural chemicals. Data processing programs have been developed to revise portions of the chemical notation (WLN) records in both the Frederick and Mitchell files of plant growth regulators. Notations have been assigned to all 8,000 chemicals in the Mitchell file. Some 4,000 records of biological response data from this file have been processed into the SEA data system and work is continuing on the remaining file of biological test data. Chemical name and associated test information in the Gentner herbicide file at BARC has been computerized in a nonstandard format. A printout of some 2,000 chemical names has been made for the purpose of developing corresponding structural diagrams and WLN descriptions. A separate file of commercially available herbicides with notations, molecular formulas, and common names is available at Frederick and can be used to retrieve other data by matching common names.

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National Research Program 20300

PEST CONTROL EQUIPMENT AND METHODS

This Program involves development of equipment and techniques to decrease production losses from crop pests, while minimizing requirements for fossil fuels and adverse effects upon the environment. The research is primarily of an engineering nature, but involves extensive cooperation with entomologists, pathologists, weed scientists, and other non-engineering disciplines.

NPS Contact: W. G. Lovely, retired
J. G. Hartsock, acting

PACS Contact: D. T. Black

Research Locations:

7602 Gainesville, Florida
7706 Byron, Georgia
7702 Tifton, Georgia
3302 W. Lafayette, Indiana
3408 Ames, Iowa
1109 Beltsville, Maryland
7502 Mississippi State, Mississippi
7402 Stoneville, Mississippi
3402 Columbia, Missouri
7803 Oxford, North Carolina
3307 Wooster, Ohio
7302 College Station, Texas
5805 Yakima, Washington

Technological Objective 1.

Develop equipment and techniques to increase the efficiency and safety of chemical pesticide applications.

Selected Examples of Recent Progress:

Aerosol droplet-size effects on mosquito control - Gainesville, FL. Initial tests to determine the optimum size for droplets of ultra-low-volume insecticidal aerosols for mosquito control were conducted with technical malathion. Results indicate aerosols with volume median diameter (VMD) from 10 to 15 microns were most efficient, with little difference in efficiency for VMD's from 5 to 25 microns.

Low-volume concentrate spraying of pecans conserves energy - Byron, GA. Use of a low-volume concentrate sprayer powered with a small tractor gave comparable disease and insect control on large pecan trees with that obtained with a large air-blast speed sprayer.

Progress on ultra-low-volume spray application equipment - Tifton, GA, and Beltsville, MD. Non-miscible liquid spray materials were successfully injected into air atomizers concurrently with spraying. Air velocities from 5 to 20 mph were tested with atomizing pressures of 10

and 20 psi. The higher air velocities resulted in the best insect control. Wettable-powder slurries were successfully applied at ultra-low-volume rates without clogging or variations in application rate by pressurizing the slurry-metering system with compressed gas.

Application of insecticides in irrigation water - Tifton, GA. Application of insecticides in sprinkler irrigation water was successful for corn earworm and fall armyworm control. Injection of the spray material at the nozzle and at the pump intake were compared, with slightly better results from injection at the pump. Four materials, including oil suspensions and water soluble materials, gave satisfactory control when applied at a rate of 0.3 cm of water per acre. Oil formulations maintained insecticidal effectiveness after an additional application of 0.36 cm of water per acre.

Performance of non-fluorocarbon aerosol propellants - Beltsville, MD. Particle size and distribution measurements were made on three non-fluorocarbon propelled aerosol cans. While there were significant differences in the volume mean diameter of two aerosols compared with the Freon check, there was no difference in the efficacy of the insecticide d-phenothrin.

Recirculating sprayer for johnsongrass control in soybeans - Stoneville, MS. New herbicides BAS 9021, HOE 29152, and glyphosate provided selective control of johnsongrass in soybeans when applied with the recirculating sprayer. Glyphosate was slightly more toxic to 'Bragg' and 'Hill' soybeans than to 'Forrest' or 'Tracy,' but soybean yields of all four cultivars were increased as a result of treatment. Neither BAS 9021 at 3 lb/A nor HOE 29152 at 1.5 lb/A caused visual soybean injury, and these treatments also greatly increased soybean yields. The efficacy of using different numbers of spray nozzles per row with the recirculating sprayer for johnsongrass control in soybeans was tested. Soybean injury was slightly increased following application of glyphosate with one nozzle per row as compared to injury obtained using four nozzles per row. Use of two or three nozzles per row did not result in increased injury over that obtained with four nozzles.

Comparisons of weed control procedures for soybeans - Columbia, MO. In comparisons of chemical and tillage methods for weed control, high soybean yields and good weed control were obtained only if the preemergence herbicide was followed by a postemergence herbicide, or at least one mechanical cultivation. A preemergence treatment of alachlor plus linuron (2.2 plus 0.69 Kg/ha) gave better control and higher yields than chloramben (2.2 Kg/ha). For postemergence, application of glyphosphate proved better than bentazon. One-half rates of preemergence herbicides were as effective as full rates when followed by two mechanical cultivations.

In comparisons of wide and narrow row culture, there was no difference in weed control nor yield between 38- or 76-cm row spacings. No herbicide treatment nor combination of treatments tested was particularly associated with better weed control for either 38- or 76-cm row spacing. A special skid-type sprayer with one nozzle per row was developed for narrow-row application and proved effective for both 38- and 76-cm rows.

Improved prototype sprayers developed - Wooster, OH. Experimental intermittent sprayers were developed to apply sprays only to target plants for vegetable or other crops having plants spaced apart within rows. Intermittent sprayers having air- and electrically-operated plant-sense controls were compared with a conventional continuous sprayer. The air-operated sprayer controlled pests on cabbage plants as well as did the continuous sprayer, and it used 31% less pesticide during the growing season.

Another experimental sprayer was assembled which pumps chemicals at the proper rate, regardless of travel speed, directly from their containers and mixes them in-line to the nozzles. All liquid flows, including flushing the containers, are controlled with switches near the operator. This should provide safer, more efficient, and effective spraying.

Air-blast sprayer output analyzed to predict performance - Wooster, OH. Orchard air sprayers rely on their air jets to deliver pest control agents. From studies of air-velocity patterns in the jets of several air sprayers, equations were developed to predict velocities at various travel speeds and distances from the sprayer outlets. Both increased travel speed and distance from the outlet resulted in decreased air velocity. Mathematical analyses of sprayer air jets indicate that for a given power input, the best spray deposition would be provided by a sprayer which delivers a high air-volume flow rate with the minimum velocity needed to achieve droplet impaction.

Improved herbicide metering device developed for aircraft use - College Station, TX. A gravity-feed system was developed for metering extruded herbicide pellets from a Piper PA-25 aircraft. An adjustable-opening metering plate controlled flow rate and a slow-turning finger-type agitator prevented pellet bridging. Flight tests were made to establish flow rate vs. opening size relationships. The equipment was used to treat numerous field test plots on four different range sites. Measured amounts applied were within 10% of the calibrated rates.

A model of a positive-feed, vaned-rotor metering device for herbicide pellets was also constructed. Information obtained from this model was used in the design of a prototype system for use on a Piper PA-25 aircraft.

Laser instrument used to study drift of spray particles - College Station, TX. Spray clouds generated by flying a spray aircraft perpendicular to the wind were scanned with a mobile laser Doppler velocimeter to remotely measure their location, spatial extent, and relative concentration as they drifted downwind from the line of flight. Replicated spray treatments were selected to simulate a wide range of pesticide drift situations. The test site was instrumented to measure weather, spray deposits, and airborne spray. Initial laser measurements showed high relative particulate concentrations in an elongated region near the release point. The region of high relative concentration then moved downwind, came closer to the ground, increased in cross sectional area, and decreased in density.

Helicopter spraying system improved - Yakima, WA. Distribution patterns and droplet sizes were determined for a Simplex Manufacturing Company spraying system on a Hughes 500 helicopter. The system with a D-6 nozzle showed an unsatisfactory distribution pattern. With Delevan raindrop nozzles (D10-45) and a boom length 6/7 of main rotor diameter, better distribution and a wider swath were obtained.

Technological Objective 2.

Develop equipment and techniques to increase effectiveness of non-chemical control of pests.

Selected Examples of Recent Progress:

Computer simulation models developed to evaluate biological control technologies - Gainesville, FL. Computer simulation models were developed to aid research on control techniques for mosquitoes and flies. These models, based on insect life histories, produce density curves for populations that are uncontrolled or are under attack by various control technologies, including sterile-male releases, parasite releases, pathogens, and insecticides. The malaria-carrying mosquito, *Anopheles albimanus*, has been one subject of simulation studies which included a subroutine for determining the potential of a population for transmitting malaria. Also, the effects of releasing the pupal parasite, *Spalangia endius*, against house fly populations have been studied.

Insect sounds associated with behavioral characteristics - Gainesville, FL. Acoustical analysis can, theoretically, detect differences among sound-producing systems. Discernment of differences among insects has importance in several areas, among which are: the detection of deviation from norms of insects mass-produced for pest suppression; the separation of strains otherwise toxonomically indistinguishable, as in newly introduced species that may constitute a greater or lesser threat, depending on exact identification; determination of the origin of an introduction bypassing quarantines; studies of the essentiality of certain behaviors subject to manipulation in pest control. Comparison of the sounds produced by several strains and species of subtropical fruit flies demonstrated that sound analysis has potential for providing such discrimination among these insects. Studies of plum curculio have determined four sounds related to specific behaviors: defense, mating recognition, premating and territoriality. The defense sound has many similar characteristics to defense sounds of several other beetles and the velvet ant.

Blacklight insect traps aid pecan insect control - Byron, GA. Blacklight insect traps were further tested both as an indicator for timing insecticide applications in pecan orchards and, at higher densities, as the means of insect control. In comparisons of spraying for hickory shuckworms on a calendar schedule and on the basis of a trap catch level of 6 shuckworms per night, three spray applications were required on a calendar schedule and five from the trap indications. However, the nut yield was 18% greater in the grove using trap scheduling.

Tests with five 15-w BL traps/hectare in a small, young pecan orchard at Florence, Texas continue to show good promise for control of the pecan nut casebearer and the hickory shuckworm. After the first generation of casebearers there was less than a 1% nut cluster infestation. Shuckworm infestation at harvest was 16% as compared to 97% in 1976.

Rearing procedures for boll weevils improved - Tifton, GA and Mississippi State, MS. A form-fill-seal machine (Kutter) for packaging was installed and modified for rearing boll weevils. Sanding and egging equipment was adapted to the machine and triggered to operate in unison with it. Cooling tunnels were designed and added which resulted in a tray-processing speed of 6-8 strokes/minute. This speed is too slow; thus, plans are under way to increase the capacity of the cooling tunnel which in turn will increase tray production. A used formseal machine was obtained. Initially, it will be modified for use in mechanizing rearing regimes of some lepidopterous insects.

Data are needed on the environment of laboratory-reared insects, especially during the larval period. Two rooms were designed, constructed, and tested. Each room may be used satisfactorily for studying or rearing insects, except in rare cases when the temperatures must be controlled closer than 2° F. (Tifton, GA)

A new diet cooler unit was fabricated and installed on a Formseal Machine to cool the larval diet. This enabled an increase in production rate from approximately 8 to 14 trays per minute. A 10 ml filler unit operated by an air cylinder was installed as an additional part of the egg planter unit on the Formseal Machine. This provided for a more uniform number of eggs per tray.

Valuable information was obtained on the requirements necessary in a conveyance vehicle for hauling the trays of pre-adult weevil forms from the rearing to the irradiation facility when needed for the eradication program.

It was also determined that room ambient air temperature does not give true inside-box temperature in the emergence boxes for weevils. The inside-box air temperature was approximately 7°F. lower than room ambient air temperature surrounding the box. Also, the temperature between trays stacked on a cart during the development period was 7.4°F. lower than the surrounding room air temperature for days 1-6 and 2.3°F. lower for days 7-13 of the development period. These lower temperatures retard the development of the weevils. (Mississippi State, MS)

Effects of tillage systems on weed populations compared - Ames, IA. In a study to compare tillage systems for production of corn and soybeans in rotation, the soybean plots that were fall moldboard plowed had the fewest weeds. Weed infestations with other tillage systems increased in the following order: spring disk, till-plant, fall chisel plow, and no-tillage. The weed control differences were not statistically significant and the levels of infestation were not sufficient to greatly affect yields. The predominant weed species tended to change from broadleaves to grasses as tillage decreased.

Drift may cause significant losses of spray ingredients - Columbia, MO. A team of engineers and entomologists found that microbial insecticide crystals and wettable powder Sevin particles are being lost from spray droplets during the atomization-transport process. Studies were made in which both the amount of insecticide (particles) actually deposited and the amount which should have been deposited were measured to determine the magnitude of the pesticide particle loss. Losses as great as 70% of Sevin 50% wettable powder toxicant and as great as 50% of microbial crystals were indicated with particular nozzles. If drift loss of this magnitude is occurring in agricultural practice, it may represent a significant economic loss to the grower and a pollution concern. Additional data on the distance of the drift will be required to assess the problem.

Predator release trial begun against tobacco pests - Oxford, NC. About 70,000 stilt bugs, *Jalyus spinosus*, were reared on tobacco in a 20' x 40' cage and released on tobacco in early spring for observation to establish guidelines for a Pilot Test Program to be initiated in 1978. A 4600 sq. ft. double-plastic-covered greenhouse was erected for the larger study and a colony of stilt bug established on tobacco in it. A yield of about 500,000 stilt bugs is anticipated by mid-May 1978 for early field releases in Bladen County, North Carolina, to feed upon eggs of lepidopteran pests.

Methods for aerial application of biological agents improved - College Station, TX. Problems associated with the aerial application of insect virus materials were investigated. Formulations containing virus, suspension agent, and bait attractant were developed. No problems were encountered with the mixing, suspending and aerial spraying of these materials. Dispersal equipment was developed for aerial application of an egg parasite, *Trichogramma* sp. for control of *Heliothis* spp. in cotton. Parasitized host eggs of *Sitotroga*, attached to wheat bran flakes, served as the carrier medium.

Solar cells used to power insect traps - College Station, TX. One solar-powered 40-watt BL trap and one solar-powered electrical grid type pheromone trap were operated at each of two sites from June through September of 1977. The photovoltaic panels, rated at 5.2 peak watts/6 working volts, were provided by ERDA. For each light trap, having a design load of 3.5 amps for a 10-hour period per day, 28 panels were used to form an array 123 by 232 cm. Four deep discharge lead-acid batteries, with a total rating of 400 amp-hours @ 12 volts, were used for storage. Four panels formed the 17 x 56 cm array for each electrical grid trap. The design load was 300 ma. over 10 hours per day. A single 95 amp-hour automobile battery was used for storage. Results from June through September 1977 indicate that the design size of the arrays and batteries is appropriate for this time period at this location.

Development and evaluation of insect traps continued - College Station, TX. A new pheromone trap (virelure attractant) for the male tobacco budworm was developed and tested. The new trap, designated as the Texas Pheromone Trap (TP-Trap) is simple, easy to construct, low in cost, requires no electricity, and is nearly 50% as effective as the standard electric grid trap.

Catches in virelure baited grid traps appear to follow field population trends during the emergence of adults from the overwintered and the F_1 generation. Competition from native females during the F_2 and F_3 generation evidently causes catches to be low during peaks in field populations of adults.

Seventy-five releases of marked boll weevils were made from April through September of 1977 to investigate the performance of the Leggett boll weevil trap baited with the artificial pheromone "grandlure." Analysis of data is continuing to determine the effect of temperature and windspeed on weevil response, as well as the directional response to the trap relative to wind direction. In addition to environmental factors, several biological factors were studied, including age, feeding regime, and exposure to pheromone prior to release.

Sequential "sticky" trap for sampling moth populations developed - Yakima, WA. Two prototypes of a trap using circular wooden plates painted "Cessna" yellow and treated with Stickum Special have been fabricated. A chamber at the top of a steel frame holds a supply of plates held in place with a pair of cams. A spring-wound clock rotates the cams to allow the plates to fall to a second pair of cams, just below an attractant holder. As a fresh plate drops from the supply chamber, the exposed plate drops into a holding container filled with spring-loaded doors. The original design called for a plate change/hour, but the initial load of 16-20 plates was too great for the clock spring, stalling the timing drive. The cams and timing were altered to change plates every 2 hours and tests are continuing.

Technological Objective 3.

Develop new and improved equipment and techniques for operational pest management systems.

Selected Examples of Recent Progress:

Development of insect population computer simulations for Corn Belt pests continued - West Lafayette, IN. Data accumulation on insect behavior, population development, and meteorological factors continued in an effort to develop computer simulations to aid producers in making pest management program decisions. Field data for enlarging a data base were acquired on Hessian fly, E. corn borer and corn rootworm behavior and population growth and development. About 80 3-hour flight response tests were conducted in a free-flight climate control chamber which concluded research to determine whether 4 ecotypes of E. corn borer adults have different response, activity and flight characteristics. A general, management oriented, insect population simulation was modified to give valid representation of Hessian fly population growth and development for spring generations in the Midwest. Chronological time is used as the driving function for non-feeding stages, while physiological time through heat units is used for the feeding stages.

Development of predictive model for insect damage to soybeans continued - Columbia, MO. Analytical work has continued on the development of functional relationships between the amount of damage done to a soybean crop

and its effect on yield, protein, oil content, seed size, number of pods per plant, and seed germination. Emperical economic threshold damage level relationships were established for five plant growth stages. The mathematical models developed appear to be adequate for predictive purposes. Several tests were run to obtain data for the development of a weather dependent green cloverworm model. Modeling of the effects of parasites and predators on green cloverworm populations was continued.

Development of automated data acquisition systems and a computer population simulation for cotton pests continued - College Station, TX. MOTHZV-2, a dynamic insect population model incorporating a large number of biological factors affecting the reproduction and survival of bollworms and tobacco budworms, proved to be a valuable component of a computer-based forecasting and information system operated by the Texas Agricultural Extension Service during 1976 and 1977 for the cotton producers of Texas. The system, named TAMU-BUGNET, is designed to provide farmers with state-of-the-art decision-making-aids for crop production and pest management.

Five locations participated in the BUGNET program in 1976 and 15 participated in 1977, covering all major crop production areas of Texas. MOTHZV was used to predict the timing of egglay peaks (± 2 days) and larval populations. Primary input data to MOTHZV-2 was daily max-min temperatures, planting and fruiting dates, and daily trap catches of bollworm and tobacco budworm moths. The extension entomologists used these timing predictions as part of the decision-making process for scheduling field inspections and recommending treatments for pests.

A Campbell CR-5 data acquisition system was operated in conjunction with boll weevil trapping research and fleahopper overwintering habitat studies. The CR-5 system includes a system clock with settable day, hour and minute counters, a battery case of 8 D cells, and a printer. Modules were added to the basic system to provide for monitoring and recording: (a) solar radiation (Lambda sensor); (b) temperatures from four locations with Type T thermocouples; (c) wind direction and velocity; (d) rainfall (tipping bucket counter-type sensor). A cassette recorder will be added to the system in 1978 to facilitate handling additional data accruing from shorter sampling periods.

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Special Research Program

MINOR USE PESTICIDES

This Special Research Program involves availability of pesticides for minor and special uses by the agricultural community and assures continuation of crop and livestock production technology for production, storage, distribution, and marketing of food, feed, seed, and fiber. These technologies will result in lowering the cost of fruits, vegetables, and other agricultural commodities and increase the efficiency of production of these crops to growers, small farmers, and homeowners. Entomologists, plant pathologists, weed scientists, chemists, and nematologists work in a team approach to develop the data required to register minor use pesticides.

NPS Contact: P. H. Schwartz PACS Contact: M. T. Ouye

Technological Objective

Develop data for use in registration of pesticides for minor crops, minor uses on major crops, and speciality uses.

Research Locations:

5206	Davis, California
7606	Orlando, Florida
7616	Miami, Florida
7706	Byron, Georgia
7702	Tifton, Georgia
3311	Urbana, Illinois
3303	Vincennes, Indiana
1108	Beltsville, Maryland
1110	Beltsville, Maryland
1208	Frederick, Maryland
1305	New Brunswick, New Jersey
3306	Delaware, Ohio
3307	Wooster, Ohio
5809	Corvallis, Oregon
7711	Charleston, South Carolina
7202	Weslaco, Texas
5806	Prosser, Washington
5805	Yakima, Washington

Selected Examples of Recent Progress: Scientists in Federal Research cooperated with state scientists on 82 food requests in IR-4 during 1977 at several locations. Of the 42 food projects initiated in 1976, 24 were completed, and submitted for subsequent registration in 1977. Of the 55 new projects initiated in 1977, 14 were completed, the remainder require additional data and will be worked on in 1978.

There were 6,000 pesticide requests for ornamental uses in 1977 in IR-4. Scientists in Federal Research participated cooperatively with state scientists in the development of data for about 600 of these pesticide requests. The data developed by Federal and state scientists was used by the IR-4 staff to develop ornamental data packages for 7 insecticides on 259 cultivars; 5 herbicides on 181 cultivars; and 1 fungicide on 33 cultivars to send to the manufacturers for registration with EPA. These data packages represent about 450 pesticide requests of the 6,000 requests on ornamentals.

Special Research Program

PILOT TESTING OF ALTERNATIVE METHODS FOR PEST CONTROL

The purpose of this Special Research Program is to secure the development and commercial use of methods of pest management that tend not to produce adverse environmental impacts and which are essentially safe for people. In other words, the new technology must be free of the problems which attended many of the broad spectrum insecticides such as hazard to man, biomagnification, toxicity to nontarget species, etc. To a limited extent, this Program will include developmental research which includes optimization of the use of environmentally hazardous pesticides. This program will foster the application of the methods of systems science in dealing with pest problems. The long-range goal is to find enduring pest management systems that would assure stable agricultural production and marketing.

NPS Contact: Waldemar Klassen PACS Contact: M. T. Ouye

Technological Objective:

To rapidly advance newly emerging technology toward implementation in order to (1) reduce net losses from pests, (2) to reduce the impacts of pest control technology on the environment either by improving current technology or by developing new technology, and (3) to reduce the hazard to man of pest control technology.

Research Locations:

Phoenix, Arizona
Davis, California
Fort Collins, Colorado
Newark, Delaware
Gainesville, Florida
Byron, Georgia
Tifton, Georgia
Lafayette, Indiana
Lake Charles, Louisiana
Beltsville, Maryland
Frederick, Maryland
Starkville, Mississippi
Stoneville, Mississippi
Columbia, Missouri
Reno, Nevada
Las Cruces, New Mexico
Ithaca, New York
Oxford, North Carolina
Brownsville, Texas
Lubbock, Texas
Weslaco, Texas
Yakima, Washington
Madison, Wisconsin

NER-77-1 - Nationwide establishment of an aphid predator. (Newark, DE). The most important aphid predator in the palearctic region is the 7-spotted lady beetle. This lady beetle has been established in New Jersey. The purpose of this pilot test is to determine the conditions for establishment of the predator in Oklahoma, Texas, Washington, Illinois, California, and Arizona. Further attempts will be made in this pilot test to establish the predator and to evaluate its effectiveness at these locations.

The 7-spotted lady beetle has now been recovered in eight counties in each of the following States: New Jersey, New York, and Connecticut, and one county each in Delaware, Oklahoma, and Georgia. Additional releases of this aphid predator were made in the fall of 1977 in Wooster, Ohio; Woodsboro, Maryland; Ithaca, New York; and Urbana, Illinois. All cooperating scientists at the above locations report that the overwintering survival of the predators was good and the chance for establishment at these new sites also looks promising.

The strain of the 7-spotted lady beetle being released in this study has been found to be nonmigratory. This helps considerably in establishment, but retards wide-area dispersal. Releases of small numbers of the lady beetles in home gardens and dwarf orchards have proven useful in controlling aphids throughout the season. For example, during the past 2 years, releases of 100 adults in a garden plot 50 feet by 150 feet prevented any aphid damage. Further, the release of 50 adults in a small grove of dwarf fruit trees caused all aphids to disappear from these trees within a period of 10 days. Comparable releases of the native lady beetle, Hippodamia, which is commonly sold in this country for aphid control would not have helped in these situations because this species disperses rapidly, even when its prey are plentiful.

NER-77-3 - Management of insects and diseases in orchards of dwarf apples. (Beltsville, Maryland). Theoretically, there are a number of advantages of producing apples from dwarf trees. The use of dwarf trees eliminates the overloading of the leaves of the lower portions of the trees with fungicides and insecticides when applying pesticides to the leaves on the upper portion of the trees. Thus, the use of dwarf trees should considerably decrease the per acre requirements for pesticides. In addition, the labor requirements for harvesting fruit from dwarf trees as well as the labor requirements of other horticultural operations should be substantially reduced. Dwarf trees are known to be highly profitable on the rich, deep soils such as Rochester, New York, or in the Netherlands. However, little is known concerning the need for irrigation and fertilization practices when dwarf tree root stocks are used on the poor Piedmont soils. The purpose of the pilot test is to assess pest problems in dwarf orchards to develop and evaluate pest management practices in such orchards, and to evaluate appropriate horticultural practices. Thus, the pilot test will attempt to identify optimal horticultural and pest management practices for dwarf apple orchards. One orchard has been established at Beltsville, Maryland, but the remaining three needed orchards have not yet been established because planting stock has been in short supply.

NER-77-4 - Suppression of nematodes with hormonal growth regulators. (Beltsville, Maryland). A number of N-substituted amides and amines and other insect growth regulators have been shown to possess very high nematicidal activity. The purpose of this pilot test is to determine whether practical use patterns can be developed for insect growth regulators against nematodes. Preliminary results indicate that the growth regulators are exceedingly effective against root-knot nematodes. However, phytotoxicity problems have not yet been circumvented.

NER-77-5 - Suppression of rush skeletonweed with a pathogen. (Frederick, Maryland). Rush skeletonweed is a serious agricultural pest in Australia and is increasing in the Western United States. The weed infests 350,000 acres of Idaho, as well as considerable acreages in California and Washington. The purpose of the pilot test is to develop the use of Chondrilla rust for managing this weed in the infested areas of the U.S. Data obtained thus far from Idaho and California indicate that certain cultures of the rust are effective in suppressing the weed.

NER-78-1 - Integrated control of golden nematode. (Ithaca, NY). The golden nematode is an important exotic pest of potatoes. Its spread within the U.S. has been retarded but not stopped by Federal and State regulatory programs. A pest management system is urgently needed to keep the nematode populations below the level at which spread is likely to occur. Current regulatory procedures rely primarily on the use of very high dosages of nematicide chemicals to keep the population densities below that level. This treatment requires taking land out of production for at least 1 year. The regulatory treatment does not eradicate the nematode. Consequently, subsequent monoculture of susceptible potatoes frequently increases the nematode density to detection levels and the land is again taken out of production for treatment. Effective nematode management systems would provide more efficient utilization of land, reduce the use of nematicides, increase crop yields, and reduce the cost of the golden nematode regulatory program.

The pilot test is designed to determine the effects of selected combinations of nematode management technologies on population dynamics of the golden nematode and on crop production. The following six treatments will be used:

1. Monoculture of a susceptible potato cultivar.

2. Monoculture of a susceptible potato cultivar plus an annual application of aldicarb nematicide.

3. Alternate year cropping of resistant and susceptible potato cultivars.

4. Alternate year cropping of an aldicarb treated susceptible cultivar and a resistant cultivar.

5. Alternate cropping of an aldicarb treated susceptible cultivar, a resistant cultivar, and a nonhost crop.

6. Monoculture of a resistant cultivar.

NER-78-2 - Suppression of weeds by enhancing the competitiveness of forages in minimum tillage systems. (Ithaca, NY). This pilot test emphasizes alternate methods for weed management after the establishment of forage and pasture crops by minimum and no tillage means across a spectrum of soils, vegetation, and climates in the Northeastern United States. It is a cooperative effort of the Science and Education Administration/Federal Research and Cornell University. In the 12 Northeastern States, there are approximately 33 million acres of land and farms. Perennial forage legumes and grasses are grown on 60 million acres including 6 million acres of hay crops and 10 million acres of pasture. Much of the land producing perennial and forage crops is difficult to plow because of the slopes, stoniness, or drainage. Erosion is a significant hazard in many acres that can be plowed. Research in New York and other Northeastern States has demonstrated that minimum tillage systems can be used to establish perennial legumes and grasses at sites which cannot be plowed. However, because vegetation control methods have been marginal and because satisfactory planting equipment was not available, these systems have not been widely used in Northeastern agriculture. Recent development of effective herbicides and minimum tillage drills have greatly increased this potential. The pilot test has two primary objectives:

1. To develop systems for establishing and managing productive forage mixtures which strongly resist encroachment by weeds in no tillage farming, and

2. To test probabilities for successful weed management, forage and pastures establishment, and longevity of production in no tillage "package for site" systems, and to provide the basis for economic assessment.

NER-78-3 - Avoidance of white rot in onions. (Beltsville, MD). The Soilborne Diseases Laboratory has found that the inoculum density of Sclerotium cepavorum, an important disease of onion that causes white rot, can be determined and correlated with the disease severity in the field. Thus, it is likely that a disease forecasting system based on soil inoculum density at time of planting can be perfected and put into use. Such a system would advise a grower which fields could not be planted to onions. When control measures are developed for this disease, the disease forecasting system would be useful to advise growers which fields need control measures.

NER-78-4 - Suppression of face flies with stickey panel traps. (Beltsville, MD). The face fly is one of the major fly pests of both beef and dairy cattle. A population of 15 face flies per animal can result in a 75 percent pink eye infection rate on cattle. Since infected animals huddle together instead of feeding, and may suffer permanent eye damage or even blindness, it is economically important to reduce the numbers of this fly. One of the major difficulties in controlling face flies by insecticides is the failure of insecticides to control immigrating flies. The use of a trap which attracts adult flies is of importance in areas where not all of the cattle can be treated. In this pilot test, sticky panel traps will be developed to attract and capture adult face flies in cattle pastures. The sticky traps will be used both alone and in conjunction with a feed-through insecticide to evaluate their ability to reduce face fly populations in pastures.

NCR-75-1 - Management of the cereal leaf beetle with resistant wheats. (Lafayette, IN). Research has shown that a dense mat of leaf trichomes deters the cereal leaf beetle from laying eggs on wheat in experimental plots of normal size. Several lines of such resistant wheats were released in 1974 and 1975.

The pilot test was initiated in fiscal year 1975 to determine (1) whether the pest would move out of wheat fields planted to resistant varieties and lay eggs on oats, grasses, and other susceptible hosts, and whether susceptible hosts, such as oats would be overwhelmed by displaced beetles, (2) whether the above mechanism can be used to concentrate the pest population in order to suppress it with parasite releases, and (3) the degree of resistance of the wheat under no choice conditions.

About 800 acres of wheat have been planted each year. The pubescent wheat "Fuzz" was found to have only an intermediate level of tolerance whereas another pubescent wheat "Downy" is virtually immune. The difference in levels of resistance was found to be caused by differences in trichome length. Previously only trichome density had been thought to be important in conferring resistance. Further, the pilot test has shown that the densities of adult beetles in resistant wheat were lower in 1977 than in susceptible wheats. However, it was not determined where the displaced beetles went. The overall reduction of larvae was 51 percent lower in resistant wheat than in the susceptible wheat. Rates of parasitism by the three major parasites of the cereal leaf beetle were not different in susceptible and resistant wheats. Finally, the low level of susceptibility of the cultivar Fuzz allows this crop to serve as a reservoir of egg and larval parasites. Resistant wheat appears therefore to be a large-acreage, insecticide-free refuge for the parasites which could then disperse into oat fields to attack the cereal leaf beetle in that crop.

NCR-77-1 - Suppression of Hessian fly by genetic means. (Lafayette, IN). Because of increased acreages of wheat being grown to Hessian fly resistant cultivars having antibiosis as the mechanism of resistance, new biotypes of the Hessian fly are developing that can overcome the sources of resistance inherent in the present cultivars. Presently, at least eight biotypes of the Hessian fly are known which differ in their ability in stuntweeds having different genes for resistance. One of the biotypes, the Great Plains race, contains dominant genes for a virulence and is being used to counteract the buildup of new Hessian fly biotypes. This method is based on mass releases of strains of Hessian flies that have dominant genes for a virulence to all of the resistant weeds grown in the Eastern soft wheat region. Hessian flies of this strain when mated to the flies found in the field produce offspring that are unable to survive on the resistant wheats even though their field parents were able to do so. The released strain itself will not survive, thereby not causing damage to the wheat in the area where the strain would be released.

Results obtained from mass releases of the virulent strain indicate that this approach is highly efficacious in protecting wheats.

NCR-77-2 - Reduction of frost damage by suppressing epiphytic ice-nucleation-active bacteria. (Madison, WI). This pilot project is evaluating the feasibility of decreasing frost damage to high-value crops including hybrid seed corn and tomatoes by altering epiphytic bacterial populations. Recent findings indicate that many plants including corn, green beans, pumpkins, tobacco, and tomato, are not inherently susceptible to frost injuries to at least temperatures of -2° to -5° C. Frost damage at these temperatures occurs only when certain epiphytic bacteria that are capable of serving as ice nucleii are preent on the crop plant leaves. Under normal field conditions, the ice-nucleation-active bacteria Pseudomonas syringe and Erwnia herbicola are present as epiphytes on these plants, and the plants are damaged at -2° to -5° C.

Both chamber and field experiments have established that alterations of the epiphytic bacterial flora can reduce foliar damage to corn plants produced by a subsequent frost. This has been accomplished with either antibacterial sprays or with competitive non-nucleating bacterium.

NCR-77-3 - Development of a mixture and rate controlled sprayer. (Columbia, MO). Most microbial and chemical pesticides are applied as liquids with sprayers that do not employ a positive metering device. These sprayers are designed to apply the proper dosage only when the sprayer travels at the speed used during calibration. These sprayers under apply when higher field speeds are used and over apply when lower field speeds are used. Furthermore, since the calibration process is complex and lengthy, there are numerous opportunities for a sprayer operator to make errors in calibration. Also needed is fingertip control to match the pesticide mixture to the pest population existing at any point in the field. The goal of this pilot test is to construct one prototype mixture and rate controlled sprayer. The sprayer will be evaluated for operator convenience, accuracy in maintaining the rates selected by the operator, adequacy of mixing the pesticide with water, and extent of transient errors associated with speed changes.

WR-75-1 - Alternative systems for managing weeds on irrigated farms. (Fort Collins, CO). Weeds are a major pest of irrigated crops, in part, because irrigation waters facilitate the dissemination of weeds and other propagules. A system of total population management is needed to inexorably reduce the tremendous weed seed reserves in the soils of irrigated farms. For the seven principal genera of weeds in irrigated farms in Colorado, the number of weed seeds per acre ranges from 1.5 million to 3.2 million. In FY 1975, the pilot test was initiated in order to compare the costs and benefits of a total weed population management system versus what is commonly accepted as good farmer practice.

The total weed management system consists of (a) use of weed-free crop seed, (b) use of screens to remove seeds and other propagules from irrigation water, (c) control of all weeds on ditchbanks by flamming or cultivation, and (d) the use of herbicides on an as needed basis. In the standard system, herbicides are used routinely along with cultivation to the extent that it can be accomplished by the farm manager.

The greatest reduction in weed seeds has occurred in the continuous corn system with 36.2 percent for total population management and 53.2 percent for accepted farmer practice. In rotational cropping systems, the decrease in the total number of weed seeds per acre has been 29.5 percent for the total population management and 21.9 percent for good farmer practice. These results indicate the strong action of powerful herbicides such as atrazine that can be used with continuous corn but which cannot be used as extensively when crops are rotated.

WR-75-2 - Suppression of aquatic weeds with a plant competitor, spikerush. (Davis, CA). Submerged and rooted aquatic weeds are a major problem in irrigation canals, ponds, lakes, and reservoirs. A nonchemical method is needed to control such weeds in order to avoid the repeated application of extensive chemical herbicides to water. Studies have already established that natural growths of the tiny plants, slender spikerush, and bark spikerush, suppress the growth of aquatic weeds in several canals and reservoirs.

A pilot test was initiated in FY 1975 to determine the feasibility of establishing moderate scale plantings of spikerushes in canals to control emerged rooted aquatic weeds. This pilot test was intended to:

1. Develop methods of producing, harvesting, and storing large quantities of seeds and tubers and of disseminating and planting the propagules, and

2. Identify ways of facilitating the effectiveness of the spikerushes in displacing weeds.

Methods of harvesting, storing, disseminating, and planting the propagules have been developed. Promising results have been obtained in small plots planted in reservoirs and canals. This pilot test will be superseded by another to begin in FY 1979.

WR-76-1 - Integrated management of pink bollworm. (Phoenix, AZ). The pink bollworm became established in the Southwest during the mid-1960's. The need for heavy use of insecticides against this pest has interfered greatly with the integrated control system that had been implemented against indigenous cotton pests. Also, the action of the pest has in some instances resulted in an increase in the aflotoxins in cottonseed.

In recent years, a number of new methods of controlling the pest have begun to emerge, including use of nectariless cotton, late-season chemical termination of fruiting, winter irrigation, and the pheromone for trapping males and disrupting natives. None of these alternative methods appear to be suffficiently effective when used alone.

In FY 1976, a pilot test was initiated to develop the individual methods and to combine them into a system of managing these pests. Delta Pineland 16 nectariless cotton was shown to reduce the infestation levels of the

pink bollworm and, in most cases, total yield standard cultivars. The experimental plant-growth regulator, Pennwalt TD-1123, was found to be superior to other materials for terminating fruiting and concomitantly lowering the overwintering of pink bollworm population. Also, this experimental plant growth regulator is an effective preconditioner to enhance defoliation. Pennwalt TD-1123 was shown to reduce immature bolls in late fall and to improve defoliation without appreciably affecting yield over a wide range of climatic, management, and varietal differences. Treated plants appear less attractive than untreated plants for egg laying by Heliothis.

WR-77-1 - Systems of weed suppression and rangeland management on sagebrush grasslands of the West. (Reno, NV). Research and actual field experience have shown that competition by good stands of perennial grasses can resist weed populations on rangeland. Competitive forage stands can be obtained through weed management, reseeding, and grazing management. Nevertheless, only 2 percent of Federally owned range is in excellent condition, 15 percent is in good condition, while 83 percent is in bad condition. Furthermore, forage production on Western rangelands must be increased by 96 percent by the year 2000 in order to assure level beef consumption in the U.S.

This pilot test is being conducted on the Gund Ranch, a working cattle ranch owned by the University of Nevada, Reno. The property includes 2,818 acres of deeded lands and had traditionally used an adjacent allottment of Federal rangeland under Bureau of Land Management jurisdiction of some 60,000 acres which together have supported the herd of some 450 to 500 cattle on a year-round basis.

The integrated program of research on range improvement and grazing management, emphasizes the replacement of weedy species with desirable forage plants. Complete control of grazing and integration of public and private lands are positive aspects of this research.

Weed control practices under study include rabbitbrush and greasewood spraying with 2,4-D for release of great basin wild rye on 1,000 acres of private rangeland. These great basin wild rye sites are potentially the most productive grazing communities in the sageland-grassland ecosystem. The degradation of 2,4-D and its fate in the environment is well known, but this rangeland community is a very alkaline-saline environment so limited studies of residues through bioassay and chemical analyses are necessary to determine the degradation patterns in the environment. Also, special interest is the influence of weed control practices on nutrient cycling in the accumulations of litter beneath shrubs killed by herbicides. This is especially important because greasewood accumulates many soluble salts.

Color infrared remote sensing is being used to predict optimum date of herbicide applications, monitor herbicide coverage, and to predict rabbitbrush mortality. These procedures have never been tested on a large scale. A second practice being studied on private lands where simultaneous sagebrush and herbacious weed control is deep furrow seeding in degraded big sagebrush-downy brome communities. The use of 2,4-D and atrazine which has been

developed at Reno for simultaneous control of sagebrush and herbacious weeds is a most promising herbicidal method in these plant communities. Mechanical methods of accomplishing these conversions are being compared with herbicide applications. Special emphasis is placed on the fossil-fuel deficiency of this comparison.

On private land where the goal is exclusively livestock production, perennial grass species are seeded for the rangebrush conversion. On public lands, special attention must be given to revegetation mixes that approach the pristine habitat of game and nongame fauna, in addition to forage for livestock production. These mixes include shrubs, forbs, and grasses.

The rangebrush conversion areas on private land are being seeded to crested wheat grass. These seedings are being used to develop methods of winter-early spring grazing. This season of use has never been researched in this environment, but is very necessary for application of innovative management systems such as fall calving. Vegetative responses in stand maintenance of crest wheat grass are being evaluated when under a winter-grazing regime for cows and fall calves.

The influence of wheat and grazing management on the nongame animal and insect populations is being studied. Of special interest is the interaction of seed-eating rodents and downy brome ecology. The pilot test will provide for economic analyses of different range improvement-grazing management options in relation to all aspects of the study.

WR-77-2 - Systems of weed suppression and rangeland management of the Southwest. (Las Cruces, NM). Mesquite and creosote bush drastically reduce the productivity of rangeland ecosystems. Research has shown that these pests can be managed so that the forage yields are increased tenfold. Nevertheless, the technology has not been adopted in the arid Southwest. Therefore, this comprehensive large-scale study has been undertaken. To further develop and evaluate chemical management mesquite and root plowing and reseeding of creosote bush infested bush, the studies on mesquite management involve a sandy dune area of 9,000 acres while the studies on creosote bush involve a block of 200 acres. The objectives of this pilot test are to:

1. Obtain accurate estimates of range improvement costs.

2. Determine production of livestock on improved ranges.

3. Determine environmental impact of range restoration measures.

4. Determine the mobility of herbicides within natural systems whether toxic, primary, or derivative compounds concentrated at some trophic layer in the ecosystem.

5. Provide quantitative data to permit the formulation and simulation modeling of grazing and management strategies to maximize livestock production while maintaining the stability of altered ecosystems.

WR-78-1 - Cultural methods of suppressing weeds and aphid vectors of diseases of sugarbeets and potatoes. (Yakima, WA). The green peach aphid transmits sugarbeet yellow virus and potato leaf roll virus. Large populations of viruliferous aphids are generated on weed hosts found primarily on the floors of cultivated orchards and on the banks of drainage ditches. Further, these weeds serve as the reservoir for many virus diseases of vegetables, ornamental, and sugarbeet crops. The major element of the visualized pest management system is the permanent replacement of weed hosts of the green peach aphid with grass cover or by cultivation.

Area-wide programs to manage the green peach aphid have already been developed in Washington, Oregon, and Idaho. An important component of these programs is the use of insecticides to suppress the aphids on peaches and other overwintering hosts in spring before they can infest crops. Although the amount of insecticide required is very small, nearly the entire aphid population is treated. Thus, the hazard of developing insecticide resistance seems high. Another component has been the burning of weeds and drainage ditches. However, this is merely a temporary control and must be repeated each year.

To conduct this pilot research project a team has been assembled including an orchard weed specialist, aquatic weed specialist, and two research entomologists. The effectiveness of different vegetation management practices in the orchard for the suppression of the green peach aphid is being evaluated in so called "clean cultivated orchards." One or two cultivations are performed in May or June rather than in just April or July. Grass cover alone and combinations of grass cover and herbicides are also being evaluated for the suppression of aphids in orchards. Similarily various vegetation management systems are being evaluated for use on ditchbanks. Emphasis is placed on a system of converting weedy ditchbanks into low-growing grassed areas. For example, competition by seeded grass species and minimal amounts of herbicides are being evaluated for suppressing weed hosts of aphids. Collection of data needed for economic analysis was begun 2 years prior to the initiation of the pilot test and will continue.

WR-78-2 - Use of resistant alfalfa in rotations to suppress root knot nematode. (Reno, NV). The pilot test is a 4-year study to evaluate the use of root knot nematode resistant alfalfa as a nematode control measure in rotations with nematode susceptible crops including potatoes, tomatoes, and sugarbeet. The objectives of the pilot test are to:

1. Determine if alfalfa with high resistance to Northern root knot nematode can be used to reduce nematode populations to noneconomic or low infection levels on heavily infested soil in large field situations.

2. Determine the effectiveness of such control on yield and quality of the susceptible crop.

3. Determine the threshold infestation levels for crop damage and its influence on length of rotation.

Alfalfa resistant and susceptible to Northern root knot nematode has been seeded in nematode infested blocks of 1 acre or more. These plots will be rotated with susceptible host crops on a 1-, 2-, and 3-year rotation. Studies are being conducted with cooperators in Washington, Oregon, Utah, California, and Nevada.

SR-75-1 - Area-wide suppression of malaria by integrated use of insecticides and sterile male mosquitoes. (Gainesville, FL). The pilot test was initiated in FY 1975 to develop the use of the sterile male technique in combination with other methods of mosquito control for the reduction of the incidence of malaria. The pilot test is being conducted in El Salvador in an area in which about one third of the people have active malaria. The work is being conducted in cooperation with the Central America Research Station of the Department of Health, Education, and Welfare. Major strides have been made in the development of mass-rearing technology so that more than 500,000 sterile males are now released each day. In addition, a genetic method has been devised and implemented for eliminating females from the culture so that only sterile males need be released. The levels of sterility in the field are generally less than 50 percent. At the end of FY 1978 the Agency for International Development will take over financial responsibilities for this experiment.

SR-75-2 - Area-wide suppression of dog fly by integrated use of parasites, sterile males, and insecticides. (Gainesville, FL). Dog flies or stable flies cause serious losses of livestock and affect the tourist industry. In FY 1975, the pilot test was initiated on St. Croix island to assess the feasibility of suppressing the pest on an area-wide basis through the combined use of parasite releases, insecticide treatments, sanitation, attractant panels, and the release of sterile males. The combined use of these techniques resulted in almost eliminating the pest from the island.

SR-77-1 - Suppression of malarial mosquitoes with a nematode parasite. (Lake Charles, LA). The mosquito-breeding area of Lake Hypostopeke, El Salvador, was treated 11 times over a 7-week period with the nematode Romanomermis culicivorax to control Anapheles albimanus and A. pseudopunctipennis malarial vectors. High levels of parasitism could be obtained only by treating at times when wave action did not interfere with efforts of the parasite to make contact with the mosquito larvae. Thus three applications made during evening hours when wind was absent and wave action had died down on the lake produced an average of 86 percent parasitism.

No significant differences in susceptibiltiy to the nematode were found between instars or between species. Mosquito populations were reduced by 94 percent. Thus, this is the first successful attempt to suppress mosquitoes on a large scale using a parasite or pathogen.

SR-77-2 - Suppression of peach tree borers with pheromones. (Byron, GA). The sex pheromones of the lesser peach tree borer and the peach tree borer were isolated, identified, and synthesized in 1973. Since the synthetic pheromone has been available for experimental use, orchard trapping studies have revealed these pheromones are very competitive with calling females in natural wild populations. Also, air permeation trials in small peach orchards have shown that both species can be disrupted or confused in their efforts to mate with the use of each others pheromone.

In the Southeastern U.S., peach tree borers and lesser peach tree borers cause more damage to peaches than all other economic peach fruit and tree insect pests combined. Losses in Georgia each year exceed $7.5 million. Growers in the Southeast spend roughly $50 per acre per year on insecticides in efforts to control the pest.

Two isolated peach orchards 2- to 4-years old each being about 60 acres in size were selected for use. Trap monitors placed within these orchards showed evidence of disruption of mating.

The effects of mass trapping of peach tree borer males were studied on a 2,000-acre area which contained a total of 550 acres of peaches. The data indicated that nearly all of the emerging peach tree borer males were captured with two traps per acre.

SR-77-3 - Suppression of filth breeding flies with parasites. (Gainesville, FL). House flies, stable flies and related muscoid flies are some of the most serious pests of man and animals. House flies in particular have developed resistance to most insecticides and are very difficult to control under most conditions. Biological control of flies particularly with programmed releases of parasites appears to be promising with the indigenous wasp Spalangia endius. This wasp appears to be particularly suitable for this purpose. It is capable of searching for house fly pupae in most breeding situations. For example, parasitized house fly pupae have been recovered 6 to 10 inches below ground. The long life cycle of the immature stages of the parasite provides for simplified handling, storage, shipment and release. Data obtained to date are sufficiently promising to suggest that the use of this parasite would be viable under commercial conditions.

SR-77-4 - Management of citrus mealybug in the Rio Grande Valley. (Weslaco, TX). The citrus mealybug became a serious pest in the subtropical area of Texas in 1970. More than 5,000 acres of citrus are now infested and the pest is causing reductions in yield of grapefruit of 25 to 50 percent.

The pilot test focuses on a management program including grove sanitation, ant control, the rearing and release of innundative numbers of brown lacewing, and the parasite Pauridia peregrina. This program includes 5,000 to 7,000 acres of citrus in a 5-mile square area near LaFeria, Texas.

SR-78-1 - Suppression of tobacco budworm with hybrid sterility. (Stoneville, MS). In 1968, Dr. M. Laster of Stoneville, Mississippi, discovered that the tobacco budworm Heliothis virescens could be crossed to a related species on ground cherry Heliothis subflexa. When hybrid females are crossed to tobacco budworm males, their sons are sterile and daughters are fertile. This pattern of sterility and fertility persists regardless of the number of backcross generations. In order to evaluate the usefulness of such hybrid sterility for managing tobacco budworm populations, a pilot test was undertaken in 1978 on St. Croix island.

SR-78-2 - Protection of sweet corn with semiochemicals. (Gainesville, FL). In 1978, a 3-year pilot test was undertaken to assess the feasibility of using the air permeation technique to control mating of corn earworms and fall armyworms in fruit corn. This approach is based on the demonstrative premise that if an appropriate quantity of synthetic pheromone or disruptant is evaporated into the atmosphere over a crop such as cotton, males are unable to respond to the sex pheromone releasing females. Thus mating is disrupted and the population suppressed by the lack of reproduction. The effects of mating control of the corn earworm and fall armyworm are being evaluated on the basis of larval damage on immature corn plants and the quantity and quality of corn ears produced relative to commercial sweet corn fields treated with conventional insecticides. Mating disruptants are being used alone and in combination with conventional insecticides to produce a second crop of sweet corn during late season.

SR-78-3 - Protection of tobacco by augmentative releases of stilt bugs and Bacillus thuringiensis. (Oxford, NC). This pilot test is intended to evaluate the feasibility of managing the tobacco budworm and the tobacco hornworm through the early season release of an important agricultural predator, the spined stilt bug. Treatment of pest populations reaching a threshold justifying treatment is being restricted to the use of Bacillus thuringiensis which is nontoxic to beneficial insects but effective against hornworms and budworms which normally comprise 99 percent of the insect problem on tobacco.

SR-78-4 - Tobacco budworm and plant bug resistant cottons in pest management programs for South Texas (Brownsville, TX). Experimental cottons that possess crop resistance to Heliothis sp. and the cotton flea hopper have been developed. These lines have agronomical properties comparable to commercial varieties. The level of resistance to these pests is sufficient to suppress populations to subeconomic levels. Thus, these cottons make it possible to utilize sound biological control practices for control of the boll weevil that could not be considered with conventional or commercial cottons. In the subtropical area of Texas, cotton flea hopper populations normally reach economic threshold levels at the time cotton plants have half-grown squares. Two pesticide applications are used to require these early pests. The pesticide applications required to control the cotton flea hopper also reduce beneficial arthropod population levels to such low levels that outbreaks of the cotton bollworm and tobacco budworm result. These outbreaks occur 2 weeks after the last insecticidal application was made for the control of the cotton flea hopper. At this time, the cotton had been blooming for roughly 7 days.

Damaging boll weevil populations are encountered each growing season. Populations reach economic threshold levels about 20 days after the plants begin blooming. The purpose of the pilot test is to determine whether the use of Heliothis and flea hopper resistant cotton will make it feasible to manage boll weevil populations without unleashing uncontrollable outbreaks Heliothis. At the 6-week stage of development, fields are treated preemptly

against the boll weevil with azinphosmethyl. A second application is being made when there are approximately 5,000 squares per acre that are one third developed. The elimination of weevils at this time reduces the weevil populations to levels that will require two generations to again reach damaging levels. Azinphosmethyl applications generally result in a buildup of the cotton aphid. The cotton aphid buildup assists in the rapid recovery of beneficial arthropod populations, thereby minimizing the risk of Heliothis outbreaks. Thus, the pilot test should determine whether preemptive suppression of the boll weevil combined with insect resistant cotton reduces the necessity for applying chemical insecticides for a major part of the growing season.

SR-78-5 - Insect resistant cottons for humid areas (Stoneville, MS, and Starkville, MS). The purpose of the pilot test is to determine if a better method of producing cotton is feasible in the midst of the rain-grown cotton belt. The pilot test involves integrated pest management with varieties resistant to insects as a base component. Varieties are such that one can use different production practices relating to insect control than can now be utilized with presently grown varieties. The test is being conducted in two different ecological areas in Mississippi:

1. An area where boll weevil is not normally considered in insect control, and

2. An area where boll weevil must normally be considered in formulating insect control plans.

These two areas will be typical of much of the cotton producing areas in the mid-South and perhaps over the Southeast.

The nectariless trait gives excellent suppression of early season insects. Early maturing cotton strains require approximately 14 days less to produce yield equal to presently grown varieties, thus escaping late season Heliothis buildup. Frego Bract gives excellent boll weevil resistance and when coupled with fall diapause control, can give almost season long control of weevils. In addition, the efficiency of insecticides for Heliothis and boll weevil is improved on Frego Bract cottons.

A full-season insecticide program is being compared with a proposed minimum insecticide program. The minimum insecticide program should prove feasible on some of the strains carrying insect resistance characters. The pilot tests will determine (a) the minimum program required in each of the two areas, (b) how the insect resistant strains and presently available non-resistant strains perform under the two insect pest management programs in the two areas, and (c) the interactions present. The pilot test is involving the use of eight variety types: Delta pine, Stoneville, Coker glabrous, high gossypol, DES-056 (very early), DES-06 (early); Frego Bract, and glandless. Each type has nectaried and nectariless counterparts. A complete insect monitoring system is being conducted and a complete set of data on insects, plant growth, distribution of yield, and total yield is being obtained.

SR-78-7 - Crop rotations for managing nematodes, diseases in weeds, in multiple cropping and minimum tillage systems. (Tifton, GA). Although rotation of crops is a traditional method for suppressing pests, the use of sequential cropping with agronomic-horticultural crops to reduce chemical inputs for pest control is a new concept. Some cropping sequences have been shown to be 2- to 4-times as effective in suppressing weeds as others. Previously, monocropping with peanuts was shown to more effectively suppress nematode populations than monocrops of corn, cotton, or soybeans. However, this is a first experiment which simultaneously measures effects of crop sequences on weeds, nematodes, insects, and plant diseases. The two major objectives of this pilot test are (1) to evaluate intensive cropping rotations with new and improved pest management systems for controlling weeds, nematodes, insects, and diseases, and (2) to evaluate the effects of various tillage methods on pest management and on crop production. Applications of chemical pesticides are minimal to optimal but not fully intensive because the study of cropping sequences involves combinations of horticultural and agronomic crops planted in the year rotations as follows: (a) field corn (March 15), sorghum (August 1), watermelon (March 15), lima beans (July 15), (b) turnips (February 15), peanuts (April 20), cucumbers (August 25), sweet corn (March 20), and soybeans (July 15), (c) tomatoes (March 20), cucumbers (July 1), turnips (September 1), corn (April 1), and Southern peas (September 1). The four tillage systems in each cropping system are (1) disc only, (2) deep plowing, (3) in-row subsoiling and discing, and (4) in-row subsoiling and planting (minimum tillage). New irrigation technology is being evaluated. An economic analysis of the management program and the cropping sequences is being conducted annually.

SR-78-12 - Augmentative biocontrol of silverleaf nightshade with a foliar nematode parasite. (Lubbock, TX). Silverleaf nightshade is a poisonous perennial weed that is becoming increasingly important to livestock production in the Southwestern U.S. However, laboratory, greenhouse, and small field-plot testing have shown that the nematode Nothanguina phyllobia, reduces vigor and reproduction and kills about 50 percent of silverleaf nightshade plants. The purpose of the pilot test is to determine the degree of control that can be obtained with the parasite, the host specificity of the nematode, and to develop inoculation techniques that can be used under practical conditions.

SR-78-15 - Augmentative biocontrol of purple nutsedge by periodic releases of a weed-feeding insect. (Stoneville, MS). Purple nutsedge is generally considered to be the worlds worst weed and as such is a major pest in cotton and soybeans in the Central Mississippi Delta. Present control methods consist of one to two early season applications of MSMA but these only serve to hold the weed in check. After the crop shade the ground, purple nutsedge growth is retarded because it needs sunlight.

Bactra verutana is the only insect known to cause significant damage to purple nutsedge by its feeding. However, the insect population does not build up until late in the growing season after the crop has already been suppressed by nutsedge growth. The purpose of the pilot test is to evaluate the feasibility of releasing Bactra into crop areas during early season for control of purple nutsedge. By rearing and releasing the insect during the early season it should be possible to accelerate the occurrence of large numbers of this insect by 60 to 90 days.

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